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The American Society for Engineering Education

Saving energy for better low-cost telephone service

Arrow points to tube containing a wire specimen under test for surface conductivity. The tube and wire are excited to resonance by microwaves from generator at extreme left. Conductivity is calculated from frequency values indicated by barrel-shaped wavemeter (top center) and resonance curves traced on an oscilloscope screen (not shown).

In the waveguides which conduct microwaves to and from the antennas of radio relay systems, current is concentrated in a surface layer less than 1/10,000 inch thick, on the inner surface of the waveguide. When these surfaces conduct poorly, energy is lost.

To investigate, Bell radio scientists devised exact methods to explore this skin effect at microwave frequencies.

Scratches and corrosion, they found, increase losses by 50 per cent or more. Even silver plating, smooth to the eye, can more than double the losses of a polished metal. Very smooth conductors, like electropolished copper, are best. An inexpensive coat of clear lacquer preserves high conductivity.

Energy saved *inside* a microwave station is available for use in the radio-relay path *outside*. So stations can sometimes be spaced farther apart, and there will always be more of a margin against fading. Here is another example of the practical value of research at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST

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Editorial

Engineering Colleges and National Defense

By HENRY H. ARMSBY

Vice President of the Society and Associate Chief for Engineering Education, U. S. Office of Education

Engineering colleges, in common with all educational institutions, are making it evident that they are eager to make their most effective contribution towards meeting national needs in the present world situation. They played an exceedingly important part in helping to win World War II through their programs of research, of educating future industrial leaders, of training engineers and subprofessional engineers, of training for the armed forces, in short, by their hearty participation in the three-way cooperation of education, industry, and government. It may be well at this time to consider briefly what they can do to serve their country in the present situation, which gives indication of being the beginning of a period of either partial or complete mobilization extending over many years.

The general conditions which the engineering colleges face now are different in several respects from those which faced them when defense efforts were started prior to World War II . Our defense preparations are much stronger than they were in 1940. A large number of industrial plants of all kinds which had to be built from the ground up during World War II are either in service or can be made ready for service with relatively small effort. We have a fair-sized Navy in "moth balls," which can be activated in much less time that was needed to build it. We have more airplanes than we had in 1940, more tanks, more equipment of all sorts, and more men in the armed forces.

But if the present situation should develop into active war, we shall need more trained men, more plants, more equipment. We shall have to make a large and rapid expansion of our armed forces, just as we did in 1940. This will create tremendous industrial needs, with their attendant problems of training.

Many references are made to the huge pool of veterans of World War II, who it is said can be prepared for service very quickly. But a large number of these veterans are unavailable for service, due to age, dependents, or physical disability. Since the number of young men in the age groups most useful for military service is much smaller than in 1940, the use of increased numbers of older men and of women will be necessary.

In 1940 the country had some 8,000,000 unemployed, forming a vast pool for enlistment in the armed forces or for preemployment training. Unemployment now is only about 3,000,000, so that a large proportion of the men called into the military services will leave vacancies in industry. It will be necessary to train other persons to fill many of these vacancies promptly if our economy is to be maintained on an even keel.

It is true that there are large numbers of veterans who have received varying amounts of technical training under the G. I. Bill. There are also a fairly large number of people who received ESMWT training during World War II, many of whom are still using that training or could be retrained for effective industrial

service in a relatively short time. But there has been tremendous technological progress since 1945, and military equipment has in general become much more complicated. A great expansion has taken place in the use of jet planes, rockets, guided missiles, and other military devices. The atomic bomb, which appeared at the close of World War II, may play a prominent part in the next war. The efforts to develop the H-Bomb may create a heavy demand on our engineering and scientific manpower, as did the A-Bomb during 1940–45. Furthermore, most of the veterans and ES MWT trainees are employed now, and if shifted to other employment will have to be replaced.

These differences are mainly differences in degree. Our engineering colleges face the same basic problem they faced in 1940, the problem of making a large and rapid increase in the number of technically trained men and women available for use in war industries, to expand these industries and to replace men drawn from them for service in the armed forces. In addition, the colleges face the long-range problem of keeping our democratic society operating. We must keep our educational plant operating to train our future citizens in the ways of democracy, for if we neglect these values, even though we win a war we may lose our democracy.

The following are suggested as some of the means by which the engineering college can help our nation meet its present needs and prepare for the period of peace which we all hope lies somewhere in the future.

The engineering college can strengthen its guidance program. Full-time enrollments will probably decrease because of the calls of students to the armed services and to war industries. It therefore will be more important than ever that each student be encouraged to enter the type of program in which he can be most successful, and hence most useful to his country.

The engineering college can make every possible effort to keep its normal educational program operating as effectively and efficiently as possible. It might consider the advisability of accelerating its program to make engineers available in a shorter time than under its normal program. It is possible that in some locations expansion of the "cooperative" principle of education may be useful both to industry and to the college. As this is written (mid-August) policies announced by the armed forces concerning the calling up of reserve officers and by Selective Service on possible deferment of college students give indications that these agencies are aware of the importance of maintaining a steady flow through the "pipelines" which will supply the future engineers, scientists, and other professional persons our nation must have if it is to maintain the American way of life.

The engineering college can make a significant contribution to planning for civil defense in its locality. In this activity it should cooperate with other educational institutions, with local health, police, and fire authorities, and with local agencies established by or through the Federal Government. Some phases of civil defense call for types of training which can probably be done better by engineering colleges than by any other agency.

The engineering college can perform a useful service by cooperation with other educational agencies in the making of community surveys to establish over-all training needs and to determine manpower resources.

The engineering college can play a very important role by providing needed industrial training, either by contracts with local industries or as a part of a reactivated ESMWT program, if one is established. As this article is written, consideration is being given to the possible need for reviving this program, perhaps on a broader basis than ESMWT, not limited to the fields of engineering, science, and management, but authorized to offer training in any field in which an emergency need for college level train-

ing is declared. However, even if it is decided to establish such a program, it will probably require some months to activate it. Meanwhile the engineering colleges need not wait for ESMWT to be revived, but can proceed to meet local training needs by direct contracts with the industries concerned.

The first step of all for an engineering college might well be to establish a college planning committee, which in a university might be a subcommittee of a university planning committee. Such a committee should survey educational facilities and staff in an effort to decide in what ways the engineering college could make its most effective contribution toward meeting a national emergency. Hysteria and hasty action should be avoided. The best interests of the country and of the engineering colleges will be served by an expeditious, but thorough and careful, appraisal of the needs in the area served by the college and by intelligent plans for meeting them. In making these plans it is at least as important for the colleges to suggest the kinds of services they can render most effectively, and which in their judgment will be useful, as it is for governement agencies to plan what services they may ask of educational institutions and their staffs.

* * * *

Washington Meetings of ECAC and ECRC

The following program sponsored by the ECAC and ECRC will consist of panel discussions followed by discussions from the floor. The meetings are open to ASEE members and members of the Engineering Division of the Land Grant College Association.

NOVEMBER 16, 1950

CARLTON ROOM, CARLTON HOTEL

2:30 P.M. TECHNICAL MANPOWER REQUIREMENTS AND MANPOWER CONTROLS

Co-Chairmen:

D. B. Prentice, Director, Scientific Research Society of America.

G. D. Lobingier, Manager, Student Recruitment, Westinghouse Electric Corporation.

Eric Walker, Executive Secretary, Research and Development Board.

NOVEMBER 17, 1950

SOUTH AMERICAN ROOM, STATLER HOTEL

9:00 A.M. EMERGENCY ENGINEERING TRAINING PROGRAMS

Chairman: H. T. Heald, President, Illinois Institute of Technology.

10:30 A.M. UTILIZATION OF RESEARCH FACILITIES AND RESEARCH PERSONNEL

The Role of the Engineer in Community Affairs*

By MORRIS LLEWELLYN COOKE

Consulting Engineer in Management

These remarks have to do largely with the over-all education of an engineer as a man and a citizen, rather than with an examination of the curricula held to be appropriate for an engineering education. The proceedings of this Society suggest that the latter has been the target toward which your major efforts have been directed. So I may find myself in the wrong pew because what I have to suggest has a not too direct bearing on curricula. Our seeming failure as a profession to recognize the relationship between engineering and a wide range of public affairs, including politics, has, I believe, implications to which we will be well advised to give increasing thought.

While fully respecting the psychologist's idea of the unity of personality, education in a democracy must recognize three distinct areas of interest and development. The first has to do with us as private individuals and the development of character, the second with us as citizens, and the third with us as technicians —perhaps in the above sequence of importance. With engineers, the middle area, i.e., citizen status, is all but ignored. Voting at elections is admittedly hardly an adequate response to public as contrasted with private responsibilities. The net influence on the community of a single vote on a ballot carrying scores of unrecognized names may be nil or has, at best, a token effect.

In such a complex and constantly changing national and world order as we recognize at the present time, there can be no excuse for any individual's failing to carry a reasonable share of the total community load. This is especially true of professional men and women, those upon whom the best we have in education has been lavished. This "community load" does not consist entirely of what we too frequently deride as politics. Indeed, the bulk of it has either nothing at all to do with politics, or at best is indirectly related to politics. I have in mind all those myriad enterprises in which men and women come together to accomplish purposes for mutual and public, as contrasted with strictly individual, benefits. They may have social, cultural, or humanitarian objectives, or a combination of all three.

Dearth of Engineers in Community Service

Various methods have been utilized to establish statistically the failure of the engineer and scientist to participate in community affairs. One recent statement shows—with the agencies chosen quite at random—that there are no engineers or scientists to be found among the directors of the following organizations: the Indian Rights Association, the American Association for the United Nations, the Brandywine Valley Association, the Foreign Policy Association, or Collier's (magazine) committee for the annual award of its Congressional medals. Among those guiding the following agencies there appears only one engineer or one scientist in each case: the Institute of International Education, the national committee supporting President Hoover's

* Presented at a General Session of the 58th Annual Meeting of the ASEE, University of Washington, Seattle, Washington, June 21, 1950.

recent elaborate report on the reorganization of the Federal Government, Public Affairs Institute, the National Civil Liberties Union, and the Philadelphia World Affairs Council. In summary, among the 468 members of these groups three were engineers—William L. Batt, Charles Edison, and your author.

Then among 200 highest grade members of the major engineering societies living in a large eastern city, only four were reported by the local Community Chest to be associated with the management of its quasi-public social activities, such as hospitals, family welfare, symphonic music, housing, and homes for the aged and children. Among another 200, only two were associated with the annual welfare drive for the financial support of these institutions. Among over 300 scientists and engineers belonging to a distinguished social organization in the East, and one choosing a considerable part of its membership with great care from among technical groups, only five were found to be associated with social agencies.

An even more significant indication of our absorption in technical affairs is the fact that among over 40 organizations selected to aid our Government during the initial United Nations Conference at San Francisco, the State Department reported at the time that "scientific and engineering groups are totally absent." These groups comprised religious, educational, labor, legal, agricultural, racial, business, and social organizations, and the latter included Rotary, Kiwanis, and Lions. There was one engineer and one scientist, both regular employees of the State Department, among about 400 individual consultants and advisers officially chosen from among a wide variety of callings.

These figures, of course, do not invalidate the fact that there are many individual engineers who give unstintingly of their time to community causes entirely disassociated from engineering, or that there are engineering schools battling more or less successfully to develop social-mindedness in their students. But these statistics do strongly suggest that among several hundred thousand individuals in the U. S. A. educated in one way or another to practice engineering, only a negligible percentage interest themselves in public affairs.

Political Distaste Breeds Indifference and Isolation

We engineers seem to utilize our distaste for politics as an excuse for laying off on all types of community service. What we are prone to denounce as politics is of course only one phase of community life, even if it is one of the most important. Through its local, State, national and international constituent parts government—or politics—is the structure by which our whole civilization is supported. It is impossible to conceive of either science or engineering without this bedrock of human society. Without government there could be no engineering as we practice it. Do not let us fool ourselves. We do not in reality stand aloof from government, no matter how we try. On the contrary, the closer we can make the tie-in between government and engineering, the greater will be the profession's opportunity for service.

Our dislike for war does not keep us from accepting our respective assignments when war becomes a necessity. So our dislike for the ethically nether side of partisan politics is not a sufficient excuse for refraining, as most of us do, from all manner of community service. Because the attitude of indifference on the part of engineers toward public affairs is that of professional men generally, does not, it seems to me, provide an alibi. We engineers must build our own place in society. Qualifying as a reasonably good citizen will, of course, require only a fraction of the time, thought and energy which go into the making of a good engineer. So the frequently used excuse of lack of time has little validity. In a recent biography of Pasteur the author remarks, "He managed to remain faithful

to the laboratory while serving society," and later the author calls him "a fervent scientist and an effective citizen."

There are many ways in which an interested citizen may make his influence felt without entering the political arena or running for office. Jefferson cited as constituting the essence of a republic a synthesis of "action by the citizens in person in affairs within their reach and competence, and in all others, by representatives chosen immediately, and removable by themselves." Another authority has said, "There are, of course, fields in which the opinion of the expert must be sought. But in every democratic process we assume that certain primary decisions must be made by persons who are not specialists in the area concerned." [1]

It has always seemed to me a mistake to urge adult engineers to enter politics in view of the fact that few of them have had the seasoning fitting them for such an exacting and specialized calling. The best training for politics is in the less specialized give and take of the garden variety of community affairs, which it is the object of this paper to advocate. And in such matters we should mix as citizens rather than as engineers. In the primary discussion of community affairs there is no demand for men with professional training. Balanced and sympathetic judgment is wanted whether it comes from the high or low, from the formally educated or uneducated. In the councils of the people we do well to try to forget that we are engineers. If something comes up where our specialized training is useful, let us utilize the opportunity. But we should not wait to be called.

Granted that there is a quite limited number of engineers so equipped and conditioned as to be able to serve society well by holding public office, there is little warrant for the undiscriminating, and at times illiterate, attitude towards politics and politicians that is generally entertained by our group. If the profession of engineering is to play its full role in the new world already in formation, we must abandon what is now almost our universal hypercritical attitude towards government and the personnel and agencies through which it expresses itself. We are associated, of course, in this attitude by a large sector of the business world. We must learn neither to despise, nor to be afraid of politics and politicians, nor even to feel removed from this all important segment of our common life. This must never, of course, excuse being a party to the illicit or the venal. Nor should it act as a bar to rating critically the individuals in public service. But it does mean establishing at all levels an always available bridge of understanding and cooperation between engineering and politics, two great and constructive agencies of modern society. A great good both to the people at large and to our profession would be effected through such a seemingly logical readjustment of our relations with the political life of the nation.

The chasm that lies between the technicians and the Congress was illustrated both grimly and amusingly by a dinner which was held several years ago at the Commodore Hotel in New York City, attended by over 1,000 scientists at $10.00 a plate. The gathering was designed as a display of confidence in Dr. Edward U. Condon, head of the National Bureau of Standards, which it was expected would help him in his still unsettled controversy with the Un-American Activities Committee of the House of Representatives. The reaction of Congress was expressed the following day by a legislator who said, "The lodge had a very expensive meeting last night." There had been no doubt on the part of any Congressman as to Dr. Condon's having the complete confidence of his brother scientists. In the absence of any bridge or means of communication between the world of science and the Congress of the United States, in holding this dinner an alto-

[1] "Time for What?" by Howard H. Brinton, in "Human Events," September 14, 1949.

gether futile step was taken. As the Congressional Committee already knew the attitude of most scientists toward most politicians, the dinner was wholly without public significance.

Education For Public Service a Continuous Process

To carry out the dream of a great democratic state, which is the only possible long-time answer to totalitarianism in its various forms, will require that the ideal of public service be nurtured at every age—through earliest childhood, school and college days, and on through postgraduate and adult life. Is should be a continuous process of community service in action. And those who interest themselves in what can be done during the four or five years of a college engineering course, which is the theme of this paper, will be handicapped if the indoctrination has not been begun in family and school in pre-college days.

One of my earliest recollections has to do with my physician father's setting up in our backyard an official weather bureau station which required certain members of a family of eight, at appointed times and by turn, to make and record barometric and other observations. This was done solely to get members of the family interested in community activities, as was the practice of having the children choose, also by turn, a subject from the morning paper for general discussion at the midday meal.

It is cardinal to my thesis that for the great bulk of engineering and science students, the four-year college course represents all but a complete monastic withdrawal from community activities. Then comes graduation and with it a pseudo-professional status which makes generally impossible the doing of those things of lesser importance which goes with any *apprenticeship*—in this case an apprenticeship in citizenship. There follows a few years of preoccupation with earning a living and before long our engineer has established an almost complete detachment from the world of public affairs. No matter how high-minded and devoted one may be to a specialized calling, like engineering, without the touch that comes from a more or less intimate association with the unsegregated and organized life of the world around us, one's efficiency will be at a decided discount as a worker and consultant on public causes.

The very process of making a technician as generally practiced is narrowing and with most people needs to be offset by other worthwhile diversions, including relatively unimportant and not too absorbing community activities. Only so can we live down the enervating and often unwarranted prejudices which any ivory tower type of life builds up concerning types not quite like ourselves —union workers, for instance, and especially labor leaders, farmers, "foreigners" —perhaps those from a nearby county, various racial and religious types, politicians, and those generally less advantaged than ourselves. Actual participation in community activities enables one to reach common ground with men and women in different walks of life. It is learning by doing, as contrasted with studying or reading about public activities.

Avenues of Approach

Once it is decided to afford college students an opportunity to make a beginning on their lives as citizens, it must be admitted that little progress has been made in working out appropriate techniques. In a recent paper[2] of mine there were assembled some first few steps taken by those convinced of the necessity of widening the students' acquaintance

[2] "It's Time to Bridge the Technology-Political Chasm" by Morris L. Cooke in *American Engineer*, April, 1950. Also see "The Habit of Community Service" in *Mechanical Engineering*, December, 1947, "Science Knocks at the Door of American Politics" in *Mechanical Engineering*, September, 1945, and "Social Indifference in the Professions" in *American Engineer*, December, 1949.

with our modern and increasingly complex world—techniques for the most part lying quite outside the classroom. My correspondence suggests that there is considerable experimentation going on and that much material would be available to any intercollegiate agency set up to advance this phase of the education of an engineer.

For instance, through Dr. Gilbert E. Doan, Chairman of Lehigh's Educational Policy Committee, I have had a glance at an unreleased syllabus for a projected series of professional development conferences with detailed sections under such intriguing captions as "The Engineer and the College," "The Engineer and the Community," "The Engineer and Society," and others.

"These discussions," says Dr. Doan, "center around the student and his development to professional status—they begin with his individual self, where his interest is keenest, and lead him to examine his world and to prepare for professional leadership in it."

There is observable here and there among the colleges a tendency to experiment on a more comprehensive basis with student, and joint student and faculty, administration. These particular extra-curricular activities seem to inspire new types of extra-mural interest. Douglas McGregor said recently, "To the extent that we can learn to operate our College democratically (and this means at Antioch the largest possible student participation) we can help to equip our students for effective citizenship in the modern world. We are humble about our accomplishments, but convinced that sincere experimentation along these lines by other educational institutions, and by human organizations of other kinds as well, is urgently needed to advance the democratic way of life. Only people who have learned responsible citizenship through actual experience can make democracy what it must become if our world is to survive."[3] It is not without significance that those colleges which have already done something actively to realize on this type of educational thinking are today planning new outlets for student community interest.

For the third year a group of 25 undergraduates recruited from Haverford and three neighboring institutions will work this summer in the Norristown Mental Hospital. The number of Haverford's participants in the Friends' foreign and domestic work camps will be increased. It is the general testimony that students taking a hand in this type of community activities have their social outlook altered and frequently modify plans for their lives in accordance therewith.

Haverford has one afternoon in the Fall when all classes are called off and most of the students volunteer to clean up the campus. Squads with a teacher and student as co-foremen cut down dead trees, rake leaves, paint grandstands, fill in gullies and such like. Faculty wives circulate with refreshments and first aid. This event affords a very easily grasped lesson in co-operative community housekeeping. At Stanford the students do similar cleaning up once a year in and about the convalescent building.

There are important lessons concerning the education of an engineer to be learned from a State-wide "Better Home Towns Development Plan" initiated six years ago by the Georgia Power Company with the objective, among others, of keeping Georgian young men and women from leaving the State. In answers to questions, many returned GI's placed unkempt hometowns as the No. 1 cause for dissatisfaction with Georgia as a place of residence. So as only one among many features in this imaginative social program, a $1,000 reward was offered to that town among over 500 with populations less than 1,000 which made the most varied progress during 1948. A simple cleaning-up was rated high in points to be considered. The results of this contest in hundreds of small towns were almost unbelievable.

[3] From *Antioch Notes*, April 15, 1950.

I mention two facts in connection with this plan which are pertinent to my thesis:

First: Before the plan was launched, 14 college-educated sales and engineering employes were chosen to have charge and then exposed during several weeks to a course of appropriate schooling, consisting of morning lectures on (1) sociology and psychology, (2) economics, and (3) municipal types of engineering. Then came talks by social workers. The afternoons were devoted to round-table discussions. Three of the fourteen "could not take it" and retired. Much of what was planned to be done throughout Georgia was actually quite remote from the normal professional field. The company reports that their difficulties were increased because the engineers put in charge had had no experience in community activities during their college days.

Second: The Georgia Power Company has made every effort to demonstrate the plan to the power companies in other states—together with its obvious and growing success. There have been engineering visitors galore. But to date the plan in anything near its totality has not been instituted elsewhere. The comment here is that those professional people who examined the scheme were so unfamiliar with normal community values, and so lacking in social-mindedness, as to be without adequate standards for judgment.

Evidence of the capacity of undergraduates to influence community affairs is indicated in a recent letter from a friend[4] associated with one of the leading law firms in my home city:

"In 1933 Pennsylvania was undergoing one of its periodic agitations for constitutional reform. To dramatize the need for this reform, to create an awareness of the pros and cons for a change in the organic law, an Intercollegiate Constitutional Convention was called. It was thought that alert, well-briefed students of political economy from the several colleges of our State could foregather at Harrisburg and, in a relatively short weekend, draft a model constitution for Pennsylvania. The Model Constitution was written. Ever since, the Intercollegiate Conference on Government, founded at the conclusion of that first Convention, meets once a year in Harrisburg, bringing together the youngsters from over fifty of our Pennsylvania colleges and universities to discuss their government.

"As to tangible benefits derived by these students from their participation, I could point out the number who have dedicated their lives to public service in the legislature, in government and social agencies and claim for the I.C.G. some of the credit. I could say that certain legislation might have been affected through the I.C.G. having dramatized the need. To me, however, the value of this foregathering of our young Pennsylvanians is as intangible—yet tangible—as freedom, as beauty. There are many communities of our State that are today better places in which to live because the Intercollegiate Conference on Government awakened in a student of a few years ago—a leading citizen of today—a civic consciousness, an awareness of responsibilities to his community far beyond that of paying taxes and shouldering arms; not a burden of residence, but a privilege of citizenship."

International Responsibilities

The seeming determination of the American people in favor of increased activities in the international field will exert a new influence on college faculties to develop greater social-mindedness on the part of their graduates and so better fit them for work in foreign parts. Both the State Department and ECA have experienced difficulty in recruiting technical staffs conditioned to react favorably in the situations normally encountered in foreign and especially in backward countries. The Friends (Quaker) Service Committee, operating in all parts of the

[4] John P. Bracken of Morgan, Lewis and Bockius.

world, recruits its staff from among those who are first of all humanitarians and then engineers or scientists, as the case may be. A noted college President stated in the late 30's that "Yale was sending forth men who knew thoroughly how to build bridges well, but had no conception of the social order for which they were building the bridges." If this was considered a disadvantage for engineers trained to practice their skills within the U. S. A., how much more serious the disability will be for those on foreign service.

There is general recognition of the need for setting aside normal practices in time of war, whatever the cost may be, if thereby our effectiveness can be heightened. As it becomes ever clearer that our cold war is almost the modern equivalent for a hot war, the same attitudes should apply. As one correspondent puts it, "A greater breadth of training for our students has been needed for a long time. Now thanks to the state of the world and the new destructive powers of science it is imperative."

My correspondence indicates that the college world is pretty well convinced that engineers must take more of a hand in the world of affairs lying entirely outside of our technical domain. Engineering *students* are our best prospects. The pedagogical problem seems to lie in the direction of doing something new while holding on tight to vital aspects of present practice, such as maintaining an ample work load on engineering students. The path ahead in this matter is not clear. But many first steps are reasonably obvious. These should be taken at once as the answer of engineering education to the oncoming grim, but inspiring challenge to our way of life. Deep waters for the American people undoubtedly lie ahead. We should go into this struggle singing but fully armored for the fray.

You Will Want To
Reserve This Date.....

JUNE 25-29, 1951

Annual Meeting

Michigan
State
College

East Lansing, Michigan

Report on Student-Faculty Evaluations*

By EDUCATIONAL METHODS DIVISION

Introduction

The Student-Faculty Evaluation Committee was established in April, 1949, to review the methods and purposes of the various programs that are used by students to evaluate the effectiveness of staff members as teachers. It was not the purpose of the committee to promote or discourage evaluation programs and the committee has tried to avoid "leading" questions that would tend to bias the replies.

The committee pursued its task by soliciting information concerning evaluation programs from deans of engineering and staff members in all schools where evaluations have been made. The information was solicited by means of a "check-sheet" questionnaire and a request for general comments. This report sums up briefly the manner in which the various programs are conducted and the faculty comments on the value and probable future of the programs.

Evaluation Procedure

Student-faculty evaluations have been used by a few schools on an informal basis for many years. Formal programs conducted on a semi-permanent basis were first developed in 1940. At the present time sixty schools have formal programs. Although a few of them are definitely permanent, most of them are being operated on a trial or probationary basis. Only ten per cent of these schools had such a program prior to 1946.

In most cases the program is conducted by a student organization in the following manner: During one of the regular class periods of every course section, near the end of each semester, the teacher excuses himself from the room and a member of the organization distributes evaluation sheets to the class. The students register their opinions of the teacher by placing check marks at appropriate places following descriptive statements. Space is also provided for the students' own written opinions or suggestions. The students do not sign their names but are asked to record their grade point average and the grade they expect to receive in the course. The sheets are then placed in an envelope and the envelope is sealed. It is retained in a convenient place until the end of the semester at which time it is turned over to the teacher for his information. In a few schools it is given instead to the administration (dean, department head, or personnel service bureau) to be used as a phase of administrator-faculty evaluation. The students themselves are not given any information regarding the results of the evaluation.

The Teacher

Teaching is a divine grace with which few people are happily endowed. Its ramifications are so numerous and so singularly significant that a true concept of the ideal entity often is lost. A few of the very many things that a distinguished teacher must *have* are (1) effectual academic training; (2) extensive experience in teaching and in professional work requiring the use of the material that he teaches; (3) a genuine interest in the welfare of the students (not

* Presented at a meeting of the Educational Methods Division at the Annual Meeting of the ASEE, Seattle, Washington, June 22, 1950.

the same thing as an interest in teaching —the motive may be different); (4) personal integrity; (5) social responsibility; (6) strength of character; and (7) teaching ability. Care must be exercised not to confuse any of the first six items with the seventh one. Academic training is sometimes misread as teaching ability—much to the detriment of the students. Teaching ability follows naturally from, and only from, a resplendent philosophy of education.

An exemplary list of the things that a good teacher must *do* would contain (1) transfer a large amount of factual information to the entire class; (2) give the students confidence in their ability to learn; (3) train the students to brush aside the superficial aspects of any controversy or problem and penetrate immediately to the central point; (4) improve the students' oral and written expressions by instruction and example; (5) develop the students' character and personality by the influence of close association in the classroom, office, community, and home.

Effective teaching is a "way of life" and a successful teacher who has resolved the various problems of his profession may well view a program by which students endeavor to evaluate his talents with some measure of justifiable doubt.

The Student

Whenever the patient judges the doctor he must base his judgment on apparent progress. The average student tends to give a high rating to a teacher under whom he makes good marks or one whose manner is cheerful and whose assignments are easy. Later he will often discover that a teacher whom he considered unpleasantly and unreasonably strict is the one who has given him his best preparation for professional life.

Most of the evaluation programs were conducted by student organizations (notably Tau Beta Pi) as a special activity, but it must be recognized that an organization cannot start an activity unless the majority of the student body is willing to participate. It has been suggested by a great many people that the programs have arisen because most of the students are mature service veterans who are critical of authority. Being cognizant of the current labor-management trends in the country they searched for and found a method of registering their ideas. The suggestion has considerable merit but only on the "maturity" count and not because the students are more critical of authority. Probably no one group of people is more critical of authority than another. The maturity of the students explains why they had the *courage* to establish evaluation programs but it does not explain why they *wanted* to start them.

Only a cursory analysis of the evaluation sheets is needed to discover that student-faculty evaluation is actually a protest against the faculty and not a desire to run the school as a special activity. The questions on the evaluation sheets are almost always expressions of "what's wrong with the teacher." On only three questionnaires were the students asked to suggest additional things that could have been done that would have helped them to learn more.

There is *no* justification for believing that the protestation is directed at any group of teachers such as young ones who are inexperienced, old ones who have not progressed, or "researchers" who consider teaching a secondary duty. Rather, there are many indications that it is a symptom of general discontent with the present teachers and their supposedly unrecognized faults.

The College

President Garfield's remark that a good college would be Mark Hopkins on one end of a log and a student on the other is perhaps the most hackneyed in the literature of American education. It is not often recalled that he also said, "I believe, then, that the two great supports of the College (Williams) are cheap bread and costly brains." In view of this state-

ment, it can be supposed that President Garfield would prefer to dispense with all deluxe buildings rather than allow the level of teaching to approach that which would require supervision by the students.

Every teacher is a good teacher or a poor one in his own way. One of the problems that each must solve in his own way is autocracy. A teacher must at all times be definitely in command of the situation, yet he should be able to enlist the willing and enthusiastic cooperation of all in his classes. Many colleges consider student-faculty evaluation programs as a desirable step toward democracy. Others feel that the end desired would be better approached by establishing seminars or discussion groups on teaching methods, and by encouraging exchange teaching with other departments and colleges.

The Future

Programs conducted by the students which attempt to evaluate teachers in a negative way with check-sheet questionnaires probably will not continue long. Programs that do not attempt to "evaluate" teachers but rather solicit constructive statements written by the students may survive indefinitely.

The committee regrets that it is unable to present a recommended program to be used for soliciting students' opinions. Additional study will be necessary before such a task can be undertaken.

By Harry W. Case
John W. Cell
Earl H. Flath
Edwin H. Gaylord
Pierre M. Honnell
George G. Lamb
W. B. Shepperd
Paul K. Hudson, *Chairman*
Student Faculty
Evaluation Committee
Eric A. Walker, *Chairman*
Educational Methods
Division

Summer Schools

The Executive Board has approved the following Summer Schools which will be held at Michigan State College either before or immediately after the Annual Meeting in June, 1950:

Engineering Drawing

Humanistic-Social Studies

Mechanical Engineering—Thermodynamics

Faculty Evaluation—A Report on the Faculty Viewpoint*

By G. G. LAMB

Professor of Chemical Engineering, Northwestern University

Student-Faculty Course Evaluation Procedures

Teacher-Course Evaluation Programs by students have been tried at many Universities over an extended period of years. Interest among students on many campuses has grown rapidly since 1945. The procedures used and the results obtained have varied from very unsatisfactory to very satisfactory.

The procedures used are as follows:

1) Student-paper editorials and articles appraising courses and teachers.
2) Student-published booklet giving detailed appraisal of courses, their teachers, etc., for guidance of new students.
3) General course evaluation questionnaires, results published in student paper.
4) Election of student representatives to handle all student complaints with administration.
5) General course evaluation questionnaires, handled by administration.
6) General course evaluation questionnaires, results to administration and teacher.
7) General course evaluation questionnaires, detailed results to individual teacher, anonymous correlation to administration and teachers.
8) General course evaluation questionnaires, results to individual teacher only.
9) Individual course evaluation questionnaires or class discussions for specific course administered by teacher.
10) General faculty opposition to all student course evaluation programs on basis of principle that a good teacher continuously studies his course, his students, and himself, so nothing is to be gained and valuable time and effort wasted by questionnaires of any sort.
11) General administrative opposition to all student course evaluation programs on basis of principle that administration and faculty continuously study courses, students, and faculty; and that it is unsound to permit students to infringe on the prerogatives of the administration.

Based on somewhat limited data available to the author, procedures 5, 6, 7, 8, 9, and 11 appear to have predominated in engineering colleges, while procedures 1, 2, 3, 4, and 10 appear to have been utilized in non-engineering colleges.

Faculty opinion ranges from active support to strong opposition to student-faculty evaluation programs. Most opinions appear based upon personal experience and sound judgment of the faculty member influenced primarily by procedure involved. Some faculty members are reported to be somewhat afraid of any such procedures by students, possibly due to insufficient experience with such matters. If careful attention is given to the details of procedure in handling such programs, it appears that the main reasons for the strong faculty opposition

* Presented at a meeting of the Educational Methods Division at the Annual Meeting of the ASEE, Seattle, Washington, June 22, 1950.

can be eliminated, although the question as to whether the time and effort involved in conducting such programs represents the optimum utilization of the faculty members' time may still be controversial.

Faculty Opinion Surveys

An opinion survey of forty-one faculty members attending the ASEE, Illinois-Indiana Section meeting on May 20, 1950, gave the following results:

1) Have you participated in student-faculty evaluation program? Yes, 81%.
2) Have you made significant changes in your teaching methods as a result of the evaluation program? Yes, 58%.
3) Do you think the average student is qualified to judge the effectiveness of the teacher? Yes, 30%, No, 17%, Some are, 53%.
4) Did you gain information that you could not have acquired by some other method, such as office conferences with the student? Yes, 71%.
5) Do you think that the student-faculty evaluation should be made a permanent program? Yes, 98%.
   a) At definite intervals? Yes, 51%.
   b) By individual instructors at any intervals they select? Yes, 47%.
6) Do you thing that the majority of the faculty considers the evaluation program important? Yes, 33%.
7) In you opinion, why was the student faculty evaluation program started? Due to student pressure—36%. Due to faculty interest—64%.

A similar opinion survey of seventeen faculty members at one institution that had tried procedure 7, above, gave similar results. (Seventy-five per cent stated that instruction was improved by evaluation program.)

To summarize the two faculty opinion surveys, it appears that:

1) The great majority (90%) of faculty members polled think that student-faculty evaluation should be made a permanent program, although nearly half believe it should be conducted by the individual instructors at any intervals they select.
2) A large majority (80%) state they gained information that they could not have acquired by some other method, such as office conferences with the student.
3) A large majority (80%) state the students are qualified to some extent to judge the effectiveness of the teacher.
4) About two-thirds reported they had made some significant changes in their teaching methods as a result of an evaluation program, although only one-third think the majority of the faculty considers the evaluation program important.
5) Several faculty members commented that the evaluation programs provide a better psychological atmosphere for learning by letting the students "blow-off steam" and by promoting better cooperation and understanding between students and faculty.
6) A typical faculty reaction is that his own rating is not quite as high as he thinks it should be, but that the summary of the ratings of his colleagues is higher than he thought. A typical student reaction is that dissenting students are more vocal than numerous.

Suggested Procedure for Student-Faculty Course Evaluation Program

Since the opinion among the faculties of engineering schools appears to be generally favorable to the establishment of student-faculty course evaluation programs, it is suggested that interested faculties consider the desirability of including the following items concerning procedure (cf. Procedure? 1st paragraph 7):

1) A general questionnaire prepared by student-faculty committee applicable to all courses to assure the expression of student opinion on the following general areas:

a) Organization of the course
b) Presentation of the material
c) Testing and grading systems
d) Student-Teacher relations

2) Encouragement of faculty members to develop special course evaluation questionnaires or discussion periods for their own courses, to complement the general questionnaire.
3) A procedure that will not require excessive costs or work by the parties involved.
4) A procedure for transmitting the course evaluation questionnaire to the individual teacher with assured anonymity for students and faculty if desired by either.
5) A procedure utilizing code numbers known only to the individual faculty member whereby anonymous correlated information could be furnished to the faculty, to the chairman of the department, and to the dean of the school involved, with the view of aiding each individual teacher to do the best teaching possible.

Utilization of Questionnaire Results by Individual Faculty Member

As in most matters of life, what the individual gets out of such a program is proportional to the efforts he expends on it. Students opinion is, of course, only one of many factors the individual should consider in appraising his course effectiveness, and most teachers will recall from their own experience changes in their own evaluation of course and teacher effectiveness made while an undergraduate and after a few years of experience in industry or in teaching.

A rapid appraisal will indicate the items of the questionnaire on which the individual is strong and weak. Several surveys have indicated that the typical college teacher is strong on "knowledge of subject matter" and relatively weak on "presentation." Considerable insight into methods of improving teaching effectiveness may be obtained by careful appraisal of all items on the questionnaires.

The main value of providing an anonymous correlation of results of all questionnaires is that it provides an objective basis for comparison by the individual of his effectiveness on any item with a distribution curve showing the effectiveness of all faculty members on each item, and therefore adds to motivation to increase efforts on those points most needing attention.

It is believed that it is the opinion of the majority of faculty members and of many college administrators that Student-Faculty Course Evaluation Programs will be most beneficial if conducted with assured anonymity for students and faculty, if desired by either. It would appear that the anonymous correlated results of all questionnaires would be of aid to administrators and faculty in determining the urgency of administration-faculty action to overcome weaknesses, but any such action should be carefully divorced from the Student-Faculty Course Evaluation Program unless the individual faculty member desires to discuss the results. It is assumed that engineering teachers entered the profession because they were interested in, and adapted to, it, with full recognition of the responsibilities involved. While few teachers will claim they have attained perfection in their calling, it is surely true that maximum performance will be attained by procedures that encourage individual self-development to the utmost.

A New Type of Course in Engineering Materials*

By JOSEPH MARIN and J. A. SAUER

Professors of Engineering Mechanics, Pennsylvania State College

Summary

In this paper, the authors review the existing practices of engineering schools in dealing with the general subject of engineering materials. It is noted that modern developments in engineering have made it necessary to consider more thoroughly the mechanical behavior of materials under widely varying types of stress, time, temperature and environmental conditions. It is, therefore, suggested that materials courses be made more technical and less descriptive, and that greater emphasis be placed on "mechanical properties," their determination, significance and use, and less emphasis be placed on "materials," as such. A possible outline of topics for a course designed along these lines is presented. A course—similar in all important respects to the one suggested—has been given in the Engineering Mechanics Department at The Pennsylvania State College for the last several years and has been found to be quite satisfactory.

Introduction

For many years, it has been standard practice in engineering colleges and schools throughout the country to require students to obtain a general knowledge of engineering materials. On the specific manner of acquisition of this knowledge, there has been no complete unanimity of opinion. Nevertheless, on the basic question of the importance and significance of this topic in engineering education, there has been general solidarity. For example, inspection of the engineering curricula in almost any college or university where engineering degrees are granted will reveal the inclusion of one or more courses in engineering materials.

The basic objective of most required course work in the general field of engineering materials might be stated as follows: to provide the student with sufficient understanding of the behavior and properties of materials, to insure intelligent selection and efficient and economical use. This is a broad objective and clearly not all aspects of the behavior of materials can be equally stressed or even considered in the limited time at our disposal. The question then arises as to which aspects of this subject shall be emphasized, which shall be de-emphasized, and which can be neglected entirely without severe loss to the student.

The answer to this question is a difficult one and cannot be made without consideration of the influence of recent advances in engineering and technology on the subject matter of materials. Some of the most important technological developments and their effect on material behavior and properties are:

(1) Increased speed of operation of machinery, requiring a more thorough consideration of dynamic and fatigue properties of materials.

(2) Higher temperature of operation of equipment—as in gas turbine, rocket and jet application—requiring a more thorough knowledge of creep behavior and of stress-strain behavior at high temperatures.

* Paper presented at the 58th Annual Meeting of the ASEE, June 1950, University of Washington, Seattle, Washington.

(3) Use of structural and machine members in which residual stresses have been intentionally introduced, requiring a knowledge of the behavior of materials in the plastic range.

(4) Advances in rolling, forming, and other fabrication procedures, requiring a knowledge of true stress-strain properties as well as plastic properties under various combinations of stress.

(5) Greater use of light weight materials in construction requiring a more thorough consideration of strength-weight ratios and buckling properties.

(6) Introduction of new materials, and new combinations of materials, requiring a re-examination of comparative mechanical properties, both from the point of view of fabrication requirements and of service requirements.

(7) Use of machines and products under greater extremes of environmental conditions, requiring a knowledge of effect on mechanical properties of low temperatures, high humidity, and corrosive atmospheres.

(8) Demands for greater safety and economy brought about by increased competition, failures of engineering constructions, and scarcity of critical materials, requiring competent stress-strain analysis together with efficient utilization of significant mechanical properties.

Most of the technological developments cited above, as well as other recent advances in engineering science and application, stress the need for more thorough knowledge of the mechanical behavior of materials and for closer union between theoretical stress analysis and the experimental study of mechanical properties. It is essential, therefore, that the future engineer be not only acquainted with the various properties of materials, their significance and use, but with the effect on these properties of other variables such as temperature, time, rate of loading, method of fabrication, etc. The experimental study of material properties should go hand-in-hand with the analytical study of stress-strain relationships and the necessity of both should be driven home by numerous simple type design problems.

Specific Nature of Existing-Type Materials Courses

It is now appropriate to examine existing-type materials courses in somewhat greater detail to see whether they meet the basic objective and the demands placed upon them by the various recent technological advances, some few of which have been discussed. Although no two collegiate institutions seem to have identical programs insofar as engineering materials are concerned, a common type of engineering materials course is a separate two or three hours per week general descriptive course covering most, if not all, aspects of engineering materials. In some institutions, the course in materials will precede the student's first course in Mechanics or Strength of Materials, in other institutions it will be given concurrently with this course, and in still other institutions it will be given along with the laboratory course in Testing of Materials. The title, too, varies from school to school, but wherever a separate course in Engineering Materials is given, it is usually known by that name or by "Materials of Construction," "Materials of Engineering," "Properties of Engineering Materials," etc. The text for the course is more often than not a well-known source book on engineering materials, such as Moore (1), Murphy (2), Young (3), Johnson (4), or Mills (5). While these books can and do serve a very useful purpose and represent excellent reference texts, they are usually far too comprehensive and voluminous from the standpoint of the detailed manufacture and fabrication of the various types of metals and alloys to have adequate space remaining for a thorough coverage of significant mechanical properties or of an adequate correlation with strength of materials or stress analysis.

In some schools, books such as Clapp and Clark (6), or Young (3) are used for courses where emphasis is on engi-

neering processes. Such courses, however, are usually special in nature and are not taken by all engineering students. In other schools, no courses in materials are required other than what is given in the standard one or two hour laboratory course in Testing of Materials. This is sometimes taught as a separate course and sometimes in conjunction with the Strength of Materials course. Here, such texts as Davis et al. (7), Gilkey (8), and Cowdrey and Adams (9) are usually used. These texts are usually written directly as laboratory manuals. They contain very little additional information on the determination and significance of mechanical properties under complex stress conditions, under widely varying temperature conditions, and under various types of dynamic load conditions.

Despite the differences from school to school, at most institutions where a separate course in materials is given, the course content will be somewhat as follows: chemistry and metallurgy of engineering materials; methods of manufacture and fabrication; physical and chemical properties and uses; ferrous materials, cast iron, wrought iron, steel; non-ferrous materials, aluminum, copper, nickel, zinc, etc.; wood and lumber products; cements and concrete; rock, stone and clay products; plastics, leather and rubber; protective coatings; testing and inspection of materials; materials specifications.

Since the course in Materials is usually but a 2 or 3 credit hour course, it is obvious that to cover completely the topics outlined above is all but impossible. Fifty years ago, the foregoing objection may not have been as valid as it is today. Since then, however, the development of many new materials, plus our increased knowledge of the chemistry and metallurgy of these materials, plus the great amount of additional data on the values of the physical properties of these materials, makes it impossible to satisfactorily treat all phases of engineering materials in one course. It appears to the authors that to cover adequately the subjects usually included in the single general type of materials course engineering schools would have to offer three separate and distinct types of courses. These courses would be: "The Processing of Materials," "The Chemistry and Metallurgy of Materials," and "The Mechanical Properties of Materials." They would be offered usually by Departments of Industrial or Mechanical Engineering, Chemical or Metallurgical Engineering, and Civil, Mechanical or Engineering Mechanics Departments, respectively. At the present time, some schools recognize this need and offer three such courses, but the engineering curriculum is so crowded that very few, if any, engineering students are able to schedule all three of these materials courses.

Aside from the time limitation on the presentation of the material usually offered in a general type engineering materials course, there would appear to be rather severe student limitations as well. With such a bewildering variety of topics to be presented, it is questionable whether students would acquire a mastery of all or even a thorough understanding of any one. Also, because of the non-analytical nature of the general descriptive-type materials course, the student has difficulty in remembering what he has heard in class or what he has read. In view of this, it appears to the authors and to some of their colleagues in the Engineering Mechanics Department at The Pennsylvania State College, that the time now spent in the standard type of materials courses can be more profitably utilized. We believe this can best be done by spent in the standard types of materials courses from the "materials" point of view to the "mechanical property" point of view. The materials part of the course must be drastically curtailed and even the part devoted to the discussion of properties of materials must be limited almost entirely to the so-called mechanical properties as distinct from the chemical or physical properties. However, the part of the course devoted to the determination, significance and usefulness of the

various mechanical properties must be enlarged and tied in much closer with the analytical course work of "Mechanics" or "Strength of Materials" and with concepts of simple design. In other words, the course must be narrowed but deepened and, by so doing, a much closer approach to our basic objectives will be realized.

Nature and Outline of Proposed Course in Materials

This brief discussion of the nature of existing courses indicates that too great emphasis is placed on "materials," as such, and not enough emphasis is given to the determination, significance and use of mechanical properties. The study of recent technological trends has emphasized also that the work on mechanical properties should be closely correlated with the analytical analysis of stress and strain on the one hand, and on the other, with the experimental determination of material behavior.

In view of the above study, the authors propose that the usual course in engineering materials be replaced by a course in "Mechanical Properties of Materials." In this course, a fundamental treatment is given of mechanical properties of materials, their importance and their significance. This is done by defining the mechanical properties of materials for conditions of static, fatigue, impact, creep loadings, high and low temperatures, and for simple and combined stresses and by stressing the usefulness of these concepts to the design of simple members and to their satisfactory performance throughout their anticipated life. Furthermore, in presenting the subject of mechanical properties, full use is made of the stress and strain relations for various types of stresses as treated in Strength of Materials. With Strength of Materials as a pre-requisite course, it is possible to show how the mechanical properties of materials are utilized in the design of machine, structural, and aircraft members. In this way, the student is better prepared to proceed with design courses.

It is recommended that the proposed course be a three or four semester hour course with one of these credits devoted to laboratory work. By determining in the laboratory the mechanical properties discussed in class, the student will acquire a better understanding of the meaning and significance of mechanical properties.

It is not proposed that all discussion of specific engineering materials be deleted. Rather, in the treatment of individual materials, it is suggested that emphasis be placed on the factors influencing the mechanical properties of these materials. For example, in the study of steel the effect of heat-treating and cold-working should be included both in the class and in the laboratory. Throughout the course, it is planned to have the student solve numerous problems dealing with the determination of mechanical properties under various types of loading conditions, and with the utilization of these properties in design of simple machine and structural members (10).

A suggested outline of topics for the new course is as follows:

TITLE: MECHANICAL PROPERTIES OF MATERIALS

1. INTRODUCTION
   - A. Objectives and Proposed Content
   - B. Effect of Recent Technological Advances
   - C. Need for Continued Experimental and Theoretical Research
   - D. Significance and Utilization of Mechanical Properties

2. MECHANICAL PROPERTIES—STATIC LOADING
   - A. Simple Stresses
     - (a) Tension — Nominal and True, Stress and Strain Relations
     - (b) Torsion—Stress-Strain Relations
     - (c) Bending-Stress-Strain Relations
   - B. Combined Stresses
     - (a) Theories of Failure
     - (b) Plastic Stress-Strain Relations
     - (c) Stress Concentrations
   - C. Hardness

3. Mechanical Properties—Dynamic Loading

A. Fatigue
   (a) Tension and Compression—Completely Reversed Stress
   (b) Torsion and Bending—Completely Reversed Stress
   (c) Effect of Range of Stress
   (d) Stress Concentration
B. Impact
   (a) Notched Bar Tests
   (b) Energy Considerations
   (c) Stress-Strain Relations
   (d) Influence of Rate of Loading
C. Damping Capacity
   (a) Methods of Measurement
   (b) Effect of Stress and Other Variables

4. Mechanical Properties—Time Effects

A. Creep
   (a) Mechanism of Creep
   (b) Deformation-Time Relations
   (c) Creep Rate-Time Relations
   (d) Creep-Rupture Relations
B. Deterioration
   (a) Effect of Atmosphere
   (b) Effect of Aging
   (c) Effect of Humidity

5. Mechanical Properties—Temperature Effects

A. High Temperature
   (a) Effect on Strength
   (b) Effect on Ductility
   (c) Effect on Other Mechanical Properties
B. Low Temperatures
   (a) Effect on Strength
   (b) Effect on Ductility
   (c) Effect on Other Mechanical Properties

6. Mechanical Properties—Ferrous Metals and Alloys

A. Factors Affecting Mechanical Properties
   (a) Chemical Constitution
   (b) Heat Treating
   (c) Mechanical Working
B. Significant Properties
   (a) Tensile and Compressive Strength
   (b) Ductility and Stiffness
   (c) Resistance to Corrosion
   (d) Availability and Economy

7. Mechanical Properties—Non-Ferrous Metals and Alloys

A. Aluminum and its Alloys
   (a) Strength and Strength-Weight Ratio
   (b) Corrosion Resistance
   (c) Formability and Ductility
   (d) Availability and Cost
B. Other Non-Ferrous Materials
   (a) Copper
   (b) Zinc
   (c) Nickel
   (d) Alloys

8. Mechanical Properties—Non-Metallic Materials

A. Wood and Forest Products
B. Plastics
C. Concrete and Cementing Products
D. Stone and Clay Products

Under each topic, the student is assigned simple design problems illustrating the use of the particular mechanical properties being discussed at the time. In a three semester hour course, it will probably be found that two-thirds or more of the semester is required to cover the first five topics; i.e., that part of the course not dealing directly with specific materials.† This leaves at most one-third of the time to discuss individual materials, their significant mechanical properties and their availability and cost. With the limited time available, only very brief consideration can be given to such topics as the manufacture, processing, metallurgy and chemistry of the materials.

It should be pointed out that some institutions have already made considerable progress in rearranging their former general materials course along the lines noted above. For example, a course, similar to that described except that it contains a total of 3 credits instead of 4, has been in operation in the Engineering Mechanics Department of the School of Engineering of The Pennsylvania State College for the last several years. As might be expected, there have been a number of changes of course content made from

† This, at least, has been our experience at Penn State.

year to year. Nevertheless, the staff is in agreement that the present course is a considerable improvement over the general, descriptive style course. The students, too, have reacted favorably and seem definitely to prefer the more analytical, less descriptive approach even though they have had considerably more to do in the way of problems and home assignments.

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College Notes

Case Institute of Technology announced the appointment of Dr. Elmer Hutchisson as acting president to serve during the leave of absence granted to President T. Keith Glennan to enable him to accept the appointment as a member of the Atomic Energy Commission. Dr. Hutchisson's appointment is effective October 1. He will continue in his position as dean of the faculty and director of research and of the graduate division.

The first step in an instructional program emphasizing nuclear power has been taken by **Columbia University's School of Engineering** with the establishment of a new course in "Nuclear Power Reactor Technology." The course is for qualified graduate students of engineering, mathematics and the sciences. Dean John R. Dunning said the School would probably offer additional new courses in the near future. Several of the science departments, particularly physics, will also participate in the program.

Lowell W. Herron, assistant to the president at **Clarkson College**, has been named Dean of the Faculty, it was announced by President Jess H. Davis. The change in designation of Mr. Herron's office is part of the administrative reorganization at Clarkson which included the simultaneous naming of William J. Farrisee as Dean of the College.

Eric Walker, of **Pennsylvania State College**, has been appointed Executive Secretary of the **Research and Development Board** in Washington, D. C.

Roman Smoluchowski, Professor of Metallurgical Engineering at **Carnegie Institute of Technology**, has been appointed a consultant to the **Research and Development Board.**

Jet Propulsion—A Chemical Engineering Elective for Senior and Graduate Students

By ROBERT A. COOLEY

Associate Professor of Physical Chemistry, University of Missouri School of Mines and Metallurgy

An outline of a one semester two hour per week course in the chemical engineering aspects of jet propulsion is presented. The course effectively reviews and extends principles of physics, chemistry, metallurgy, ceramics and engineering while providing an introduction to a rapidly developing field of engineering of considerable interest for its practical and scientific uses. The relative novelty of the subject, current newspaper and newsreel attention, plus many satisfying but not too advanced theoretical analyses of jet propulsion phenomena work together to maintain a high level of student interest. The chemical engineer's and the chemist's appropriate interest in this field is clearly demonstrated.

Introduction

Announcements such as (a) 62 ton Boeing XB47 Stratojet spans the United States in less than 4 hours at a velocity of over 600 miles per hour, (b) Military requests 200 million dollars from Congress for 3000 mile rocket range, (c) Secretary of Defense announces that United States has an "Earth Satellite Vehicle" program, and (d) Engineering data now exists for construction of Los Angeles to New York passenger carrying rocket, are powerful stimulants for the technically inclined imagination as well as that of the news commentator. Jet propulsion with its unique features in the field of propulsion has not been put away with the mothball fleet but is becoming possibly more important as an area for engineering development than it was in wartime. The basic principles of jet propulsion are easily learned; but what is being done to develop the engineering knowledge needed to reduce these principles to broader practice? Many engineering educators were not able to evaluate jet propulsion with confidence and realism during the war due to secrecy. Now the public has access to many developments achieved with public funds.

Each university has to decide whether to include specific courses in jet propulsion in its curriculum and which if any of its engineering divisions, aeronautical, mechanical or chemical, should offer courses. Although a few[1] courses of unrestricted military security have been offered in jet propulsion, an increasing number of engineering schools may be expected to offer courses in jet propulsion. Courses were given for military personnel during the war[2] at educational

[1] See texts for courses written by authors from Purdue University, University of California, Ohio State University and University of Michigan: a. Principles of Jet Propulsion and Gas Turbines, M. J. Zucrow, Wiley, 1947; b. Rocket Propulsion Elements, G. P. Sutton, Wiley, 1949; c. Introduction to Gas Turbine and Jet Propulsion Design, C. A. Norman and R. H. Zimmerman, Harper Bros., 1948; and d. Theory and Design of Gas Turbines and Jet Engines, E. T. Vincent, McGraw-Hill, 1950.

[2] Malina, Frank J. "Jet Propulsion—Its Effect Upon Engineering Education," Pacific Southwest Section of Society for Promotion of Engineering Education at University of California, Feb. 22, 1946.

TABLE I—OUTLINE

CHEMICAL ENGINEERING ASPECTS OF JET PROPULSION

I. History and Current Status
   - A. Technical Progress Chronologically
   - B. Analysis of a Modern Large Scale Engineering Effort to Develop Jet Propulsion (OSRD* methods and results)

II. Fundamentals of Jet Action
   - A. Newton's Laws
   - B. Momentum
   - C. Basic Principles of Rockets and Nozzles
     1. Maximum velocity of a rocket
     2. Nozzle theory
     3. Thrust of a rocket
     4. Specific impulse
     5. Efficiency of a rocket motor
     6. Burning law for solid propellants
     7. Effect of temperature on burning of propellants

III. Morphology of Jet Propulsion Devices

IV. Combustion in Jet Propulsion Devices
   - A. Thermodynamics
     1. Energy release
        - a. Frozen equilibrium
        - b. Shifting equilibrium
     2. Flame temperatures
     3. Methods of calculation
     4. Applications of spectroscopy
     5. Comparison of JP combustion problems with other combustion problems
   - B. Chemical Kinetics
     1. Theory
     2. Experimental results
   - C. Engineering Applications of Thermodynamics and Kinetics
     1. Internal ballistics of solid propellant rockets
     2. Internal ballistics of liquid propellant rockets
   - D. Heat Transfer
     1. Theory
     2. Results

V. The Rocket
   - A. Operation of Liquid Propellant Rockets
     1. Hydraulics
     2. Ignition
     3. Cooling combustion chamber and nozzle
   - B. Operation of Solid Propellant Rockets
   - C. Performance
   - D. Design

VI. The Ramjet
   - A. Principles of Operation
   - B. Diffuser
   - C. Combustion Chamber
   - D. Nozzle
   - E. Performance

VII. The Pulsejet
   - A. Principles of Operation
   - B. Performance

VIII. The Turbojet
   - A. Principles of Operation
   - B. Ram and Mechanical Compression
   - C. Turbine
   - D. Performance

IX. The Turboprop
   - A. Principles of Operation
   - B. Performance

X. The Testing of Jet Propulsion Devices
   - A. Types of Tests
   - B. Instrumentation Installations and Problems

XI. Chemistry of Propellants
   - A. Storage Stability
   - B. Chemical and Physical Properties
   - C. Theoretical Predictions
   - D. Composite Chemical Evaluation of Propellant Systems

XII. Manufacture of Rocket Propellant
   - A. Raw Materials
     1. Nitroglycerin
     2. Nitrocellulose
     3. Liquid oxygen
     4. Liquid hydrogen
     5. Liquid fluorine
     6. Hydrogen peroxide
     7. Hydrazine
     8. Aniline
     9. Nitric acid
   - B. Unit Operations
     1. Mixing
     2. Drying
     3. Extruding
     4. Machining
     5. Inhibiting

XIII. High Temperature Resistant Materials
   - A. Metal Alloys
   - B. Ceramics

XIV. Economics of Jet Propulsion

XV. Current Examples of Jet Propulsion Devices

* Office of Scientific Research and Development.

institutions. At the request of the Army Air Forces Professor Th. von Karman in 1944 at the California Institute of Technology initiated a graduate course in jet propulsion for training officer personnel. This course required a year and involved the study of such subjects as aerothermodynamics, chemistry of jet propulsion, high temperature materials, rockets, thermal jet propulsion systems, and applications of jet propulsion systems.

Since exploitation of the principles of jet propulsion for military purposes during the war was carried out by physicists, chemists, chemical engineers, aeronautical engineers, mechanical engineers, metallurgists, civil engineers, mathematicians, astronomers and others, few strong prejudices have yet arisen as to what kind of training is most valuable for young jet propulsion research and development workers. The type of worker most in demand is the one who has abilities and attitudes that tend to fit him for the much discussed title of research engineer—one with keen engineering judgment and sensitive acuteness to the implications of scientific research results.

The part of jet propulsion concerned with the theoretical prediction and practical evaluation of propellants, combustion, and ignition phenomena offers the chemist or chemical engineer a challenging task which can utilize his fundamental training efficiently. Design of combustion chambers and propellant handling equipment and material selection problems can also be assigned to chemical engineers, although engineers of different training (mechanical, metallurgical, aeronautic, ceramics) may be preferable in some cases. Jet propulsion development centers may prefer to train young technical graduates in jet propulsion after they have received their basic training in universities, but an appreciable number of students may find it worthwhile to elect an introductory course in jet propulsion.

The establishment at the California Institute of Technology and at Princeton University (through funds of the Guggenheim Foundation) of two National Centers for the Study of Rockets and Jet Propulsion indicates the academic interest in the non-military study of the fundamentals of rockets and jet propulsion. These centers would seem to provide excellent locations to carry out unclassified research and instruction on jet propulsion. They are highly desirable in view of the purely scientific interest in jet propulsion per se and as a scientific tool separate and distinct from commercial or military applications. Other schools which offer at least an introductory course in jet propulsion should provide a natural feeder system for the centers.

A jet propulsion course (Outline—Table I) as presented at the University of Missouri School of Mines and Metallurgy is offered by the Chemical Engineering Department and requires two class hours each week for an 18 week semester. Prerequisites for the course are senior or graduate standing in chemical engineering, chemistry, metallurgy or ceramics. The course is an elective one and appeals to some students as an introduction to a well advertised and imagination stimulating field of engineering in which they feel that most things humanly possible may not be completed before they start the course.

Conclusions

As the outline indicates jet propulsion is replete with instances in which rather satisfactory predictions may be made with the knowledge a senior engineering student has acquired. Thermodynamics, hydraulics, and strength of materials appear much more interesting and worth mastering to a student who not only considers these subjects in the class room, but also sees and hears their results in the newspapers and movie newsreels. The student is required to design completely a solid or liquid propellant rocket with reasonable specifications before the course is completed.

Although the course introduces new material, it presents an excellent opportunity to review briefly and extend, with particular aims in view, principles of physics, physical chemistry, chemical engineering, metallurgy and ceramics. Presentation of testing methods introduces opportunities to discuss electronic recording of pressures, temperatures and mass flows under very rapidly changing conditions. A rather detailed study of the design features of a German V-2 rocket is included.

There is little difficulty in finding sufficient open literature for the course. Since 1940 there have been more than a thousand articles (exclusive of newspapers) and thirty-six books on jet power plants and gas turbines published.

College Notes

Albert Kingsbury Hall, the **University of New Hampshire's** new million-dollar home for its College of Technology, was dedicated in a two-day ceremony on October 13 and 14. The largest of more than 45 major classroom and dormitory buildings on campus, it is named for the University's first professor of mechanical engineering who served from 1889 to 1899. A symposium developed around the theme "Technology in the Service of Mankind" featured the first day of the celebration.

The appointment of L. F. Stutzman as Chairman of the Department of Chemical Engineering in the Technological Institute of **Northwestern University** was announced. Professor Stutzman succeeds V. C. Williams who resigned to accept a position as Chief Engineer of the General Anilin and Film Corporation. Miklos Hetenyi, Professor of Mechanical Engineering at **Northwestern University** has been appointed to the first Walter P. Murphy Professorship of the Technological Institute.

THE COOPERATIVE DIVISION

will hold a

Mid-Winter Meeting

at

The University of Florida

Gainesville, Fla. ***January 9 and 10, 1951***

Industrial Growth and Formal Engineering Training*

By FRED T. AGTHE

Process Engineer, Allis-Chalmers Company, Milwaukee, Wisconsin

Within recent years so much attention has been given to subjects that pertain to industrial growth and formal engineering training, that one may discuss them only in an atmosphere of caution and diffidence. Those of us of an earlier generation recall the attitude of a large part of American industry toward the employment of the college graduate of that period. In industrial fields, the college or university graduate was not too popular or in urgent demand—he was forced to demonstrate his ability and usefulness in the shop, railroad, or the mine, before he was considered of sufficient value to his employer to warrant receiving an adequate living wage.

During the period to which I refer, a man whether college trained or not, was appraised largely on the merits of his ability. The modern trend is a departure from this concept, for mass action pressure groups, believe that life is too short and too evanescent to waste time on crucial time-consuming tests, and that people trained for certain activities by formal methods should reap, before it is too late, the fruits that are there for the picking.

I am not trying to be facetious, for I am convinced that much of what is done today in the many activities of our complex society is carried on with an utter disregard for intrinsic values and the relative merit of things. Perhaps it is due to abject ignorance, both religious and secular, of the principles upon which real and lasting values are based, and in that respect our elaborate system of universal education has been weighed in the balance and has been found wanting.

Despite these somewhat dismal comments on the condition of our times, the training of able young men for a career in the field of engineering is a vitally important activity. I can think of nothing of greater value to our nation than an educational institution endowed with great teachers who are men of character, and whose lives are devoted to the training and inspirational guidance of young men in a line of work for which they are best fitted.

Trends in Education

Returning a little closer to the subject of this address, it is apparent without further comment that the demand made by American industry on colleges and universities for young engineers is representative of our times, and the old order of past generations will not return. Educational institutions and industry alike, therefore, now face the realities of a situation that is here to stay. It becomes necessary for both groups to be introspective and to examine themselves, the situations, and trends so that they may be formed and developed into a new pattern that will redound to the best interests of all.

There appears to be no diminution in the growth of the activities of applied science. Even now new agencies are at work in Governmental departments and in large industrial organizations in studies

* Presented before the North Midwest Section of the ASEE, State University of Iowa, November 5, 1949.

of the use of atomic energy for power generation, for therapeutics, and other activities that are important to the progress and well-being of the nation. There seems, therefore, to be no limit to the expansion of engineering development per se, and unless the social system should collapse completely, there should be an ever-increasing need for men who are thoroughly trained for these greatly augmented activities.

Recent discussions conducted in the meetings of this Society and published in *The Journal of Engineering Education* convey the thought that educators are giving earnest consideration to the increasing demand for highly specialized, technically trained people. Many of us who are employed in industry also have long realized that there are places of technical employment in the modern plant that do not require complete conventional engineering training, and that specific training of a terminal nature would be sufficient in preparing for full employment at adequate compensation. The so-called technical institute no doubt will be developed in the future to train many technicians for jobs in American industry that are now filled by college-trained young men who have received a Bachelor of Science degree in some branch of engineering.

The growth and development of the Technical Institute in larger industrial centers should meet these needs of modern industry. Thus accredited colleges that teach engineering should be relieved of the pressure of rapidly increasing enrollment, and would be able to devote more time to the teaching of the basic sciences—the fundamental engineering subjects—and to conducting the socio-humanistic courses that are now regarded as necessary for the broad education of engineers of the future.

The growth and development of applied science have taken place so rapidly, that their full impact on colleges of engineering has not been fully realized. Like most great movements leading to change, the vital factors were at first not apparent. World War II accelerated the development, and the over-crowding of engineering colleges brought to focus the dilemma toward which engineering training was drifting.

The committee on Relations With Industry, organized and conducted so ably by the late Dr. A. R. Stevenson, has devoted its efforts to the study of problems that are common to industry and the college. Its activities have become so widespread, and have been considered of such importance, that the committee has become a division of ASEE, which is an indication that constructive work has been attempted and will be continued by a greater number of the members of the Society.

Engineering is the Nation's third largest profession, and is growing rapidly. It has been estimated that jobs in engineering may increase by as many as 100,000 within the next twelve years to a total of approximately 450,000. In order to train men for the technical skills that are needed to keep abreast of these developments, a serious appraisal must be made of formal engineering training. This may indicate the necessity of separating the field into two parts, one for the training of technicians and one for the training of technologists.

In the report published by the Committee of Undergraduate Curricula in *The Journal of Engineering Education* for September 1949, pertinent suggestions are made that pertain to the future development of formal engineering education. Under the caption "Principles Which Should Guide the Development of an Undergraduate Program in Engineering," the Committee concedes that the four years spent in undergraduate work is long enough for a sound engineering course in which the fundamentals are taught thoroughly.

It would seem obvious that with the great growth of technology in all of its branches, the formal training at a university can include only the fundamentals of engineering. This would be true even though the course was longer than four

years. Thus it would be up to the student to round out his training for the work in which he will be engaged either by postgraduate work, or by enrollment in a graduate training course conducted by industry.

In analyzing this suggestion, it must be recognized that there is a dividing line in all engineering activities beyond which a high degree of formal training in basic science is necessary, and below which concrete practical instruction, based upon the rudiments of scientific principles, will suffice. Such training would fall within the category of the instruction that is available in the technical institute or the school or terminal technical education.

In Milwaukee, over the past four years, there has been established a committee known as the University Cooperating Committee of the Wisconsin Society of Professional Engineers. This committee was formed at the suggestion of the University of Wisconsin. It was believed that the Committee might be able to obtain the concerted opinion of the engineers of the State regarding the trends in engineering development and the changes required of enginering colleges to meet them. The Committee, composed of some leading industrialists and engineers employed in private and State activities, has met conscientiously over the years and has worked in harmonious collaboration with the faculty of the Engineering College of the University of Wisconsin. In addition to the many other subjects that have been discussed, there has been given considerable attention to terminal technical education. In order to clarify the position that the Committee has taken, I shall take the liberty to quote in part, the recommendations that have been made concerning terminal technical engineering training.

RECOMMENDATIONS

"1. The Committee believes that there is a distinct need for the technical institute graduate who is a trained technician in some specialized field. Such men will assist professional engineers in design, experimental and production work in industry.

"2. The Committee believes that the training of such men should be given in technical institutes which are provided with the proper faculty and equipment. It should not be an auxiliary course to apprentice training but should be a separate and distinct curriculum. The technical institutes preferably should be located where the particular specialty or specialties taught can be utilized in nearby industry. No attempt should be made to teach all specialties in each technical institute or even in any one school.

"3. The Committee believes that publicly supported technical institutes can best be organized and administered by the State Board of Vocational and Adult Education. Because of the present existence of vocational schools in most industrial sections of the State, it would be possible to teach the various specialties where there is a need for them in that locality.

"4. The Committee believes that the technical institute courses should require a maximum of two years' time and should be specialized and terminal in nature, as training for a specific job in industry. The large majority of its graduates would enter industry on completion of their courses. A relatively few individual graduates may for some reason wish to continue with a university engineering course. It is recognized that the technical institute's personnel, texts, and course contents will be quite different from those of engineering colleges. Therefore, it is not possible to give equal or even definite partial university credit for technical institute work. The accreditation should be on an individual basis where transfer to the College of Engineering is requested.

"5. The Committee believes that the technical institute course should not be over two years in length and all attempts to expand it into a longer course or to make it equivalent to the University College of Engineering should be discouraged."

The late Dr. W. E. Wickenden, when President of the Case School of Applied Science, is reported to have said, "Engineering is an art and a profession upon which we depend for our prosperity in peace and for our survival in war. It is based partly upon science; but chiefly

upon personal qualities, technological judgment, wisdom and enterprise of its professional members, and upon the skill, experience and reliability of its craftsmen." It is to this larger craftsmen group in the development of formal technical training that one must give serious consideration. To that definition I would add the skill, experience and reliability of its *technicians* and craftsmen.

There seems to be more clearly defined than ever, a line of demarcation between technician and the technologist. It is true that the consideration of the technical institute in our scheme of technical training will have a salutory effect upon engineering training in all its branches. The technical institute, its progress and development should and must be guided with an open mind. Those who bear that responsibility will face opposition; and there are many factors involved that present problems which will be difficult to solve. Whatever may be the outcome, a serious responsibility rests upon educators, industrialists and engineers alike. The solution should and must be found in the intelligent and vigorous establishment of improvements in formal engineering training that lie within the framework of our democratic society. Whatever changes are made must conform with the basic principles of the American way of life.

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3. "Mineral Engineering Education of the Future in the Light of Present Day Research Problems." Presented by F. T. Agthe at the Annual Meeting, Mineral Industry Education Division, American Institute of Mining and Metallurgical Engineers, University of California, Berkeley, California, February 13, 1949.

THE ENGINEERING DRAWING DIVISION

will hold a

Mid-Winter Meeting

at

Texas A. & M. College, College Station, Texas

January 18, 19, 20, 1951

A Possible Technique for Determining the Relationship Between Certain National Indices and the Demand for Engineers

By W. P. WALLACE, H. W. CASE, and L. M. K. BOELTER *

At the national ASEE meeting held in Austin, Texas, in 1948, one of the authors presented a short report showing the relationship existing between the indices of industrial fuel (gas and electric power) consumed by industry in the State of California and the number of engineers graduating from engineering colleges. This relationship was shown graphically by means of increases or decreases in yearly percentage, using 1935 as a common base. That a relationship might exist with this index of industrial size and the number of engineering graduates, as well as the number of members belonging to societies, seemed indicated from the similarity of the curves which were developed.

As a result of these tentative indications, it was deemed advisable to explore a number of known national indices, using these indices as variables to attempt to determine if any relationship existed between them and the number of engineering graduates obtaining employment in the engineering field. If a relationship could be established between this variable and an index or indices, it might be possible to develop eventually a method of utilizing the index or indices to predict the number of engineers who would be hired for a given year. Since the number of engineering graduates hired by industry for engineering positions has not been compiled on a yearly basis, it seemed desirable to test the hypothesis by attempting to predict (1) the number of members belonging to the engineering societies, (2) the number of engineers registered in the various states, and (3) the number of neophyte engineers graduating from the engineering schools through the method of determining the inter-relationship existing between them and other national indices used as variables. One of the major difficulties in an investigation of this nature is that the various indices show considerable variability in the length of time in which they have been compiled. This factor has necessitated the restriction of this study to the period extending from 1929 to 1948. The indices as they are compiled nationally are not directly comparable; therefore, in order to make the data comparable, they were converted into percentages of increase or decrease, using 1935 as a common point. For the purposes of this experimental study the following indices were used as variables:

1. Society membership
2. Retail store sales
3. Total energy
4. Wholesale price index
5. National income
6. Production index
7. Dow Jones averages
8. Consumer price index
9. Government non-war spending
10. Engineering graduates
11. Registered engineers

The first step in the analysis consisted of plotting the actual percentages of increase or decrease from 1929 to 1948

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TABLE 1

RAW DATA

Year	Society Members (1)	Retail Store Sales (2)	Total Energy (3)	Wholesale Price Index (3)	National Income (2)	Production Index (3)	Dow-Jones Ave. (2)	Consumer's Price Index (3)	Govt. Non-war Exp. (3)	Engr. Grad. (4)	Regist. Engrs. (5)
1929	117	124	126	119	129	126	244	124	33	67	38
1930	118	127	112	108	121	104	193	122	38	66	50
1931	120	117	97	91	113	86	109	111	49	79	65
1932	119	95	83	81	91	67	55	99	73	92	81
1933	105	91	90	83	85	79	66	94	61	97	91
1934	100	93	95	94	91	86	82	98	91	103	95
1935	100	100	100	100	100	100	100	100	100	100	100
1936	103	116	113	101	113	118	138	101	122	97	107
1937	108	120	121	108	120	130	130	105	107	98	114
1938	114	118	105	98	120	102	108	103	100	100	129
1939	119	132	114	97	132	125	116	101	121	114	149
1940	125	144	127	98	146	143	110	103	111	130	162
1941	131	156	137	109	169	175	100	107	93	131	167
1942	137	143	147	124	195	228	89	119	90	138	172
1943	143	149	154	129	227	274	111	126	76	132	177
1944	148	163	166	130	247	270	120	128	93	116	182
1945	157	177	163	132	244	233	145	131	131	73	187
1946	169	202	160	151	208	195	158	143	208	99	202
1947	183	187	178	191	185	215	155	163	206	181	253
1948	200	183	182	206	190	220	158	174	228	258	294

All data expressed as a percentage of the item of 1935 = 100%.

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using 1935 to represent one hundred per cent. The result was a formidable array of curves yielding little or no information as to relationship that might possibly exist between the variables. Similarly, due to this same high degree of variability, it was impossible to determine whether any one or more combinations of the variables might predict better than other possible combinations.

In order to measure the existing relationships it was decided to ascertain the inter-correlations existing between the variables (Table 1), and to subject these inter-correlations to a factoring technique to discover whether certain combinations of the variables could be used to formulate a regression equation for the purpose of prediction. It should be noted at this point that the authors are fully aware of the dangers and pitfalls that exist in the artifacts that are often encountered in applying the correlation technique to small samples. Therefore, since it was impossible to get time series data beyond 1929 for many of the indices, and while they recognized these dangers in using small amounts of data, it seemed advisable to explore the possibilities of this method of approach.

Utilizing the factoring technique developed by Gengerelli (6) a multiple correlation of .96 for society members is reported when the significant independent variables were shown by the factoring to be: consumer price index, national income, and government non-war spending. For the engineering graduates a .77 coefficient of correlation existed when the significant variables were found to be the wholesale price index, and government non-war spending. A 1.00 correlation coefficient was obtained between the registered engineers and the significant variables of government non-war spending, national income, and engineering graduates. The indices which were found to give the highest multiple correlations with each of the variables being solved for, were then used in a regression equation (6) according to their indicated factor loadings as shown by means of the factor analysis. The regression equation was then used to determine the predicted relationships year by year from 1929 to 1948. The actual and predicted relationships are shown in Figs. 1, 2, and 3. The very magnitude of the correlation coefficients, and the close correspondence between the

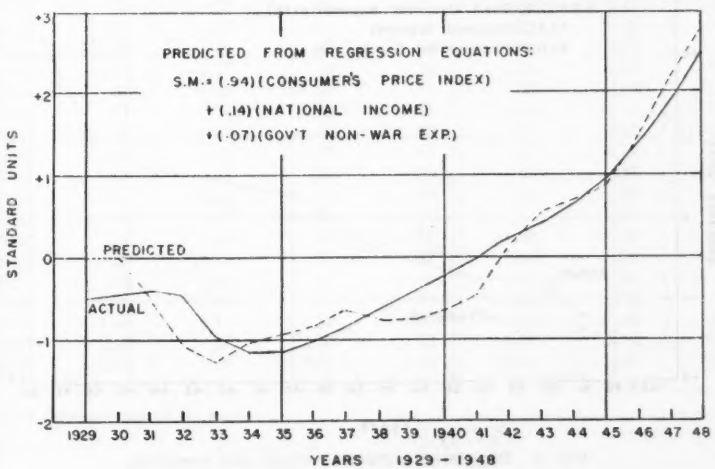

FIG. 1. Societies memberships—actual and predicted.

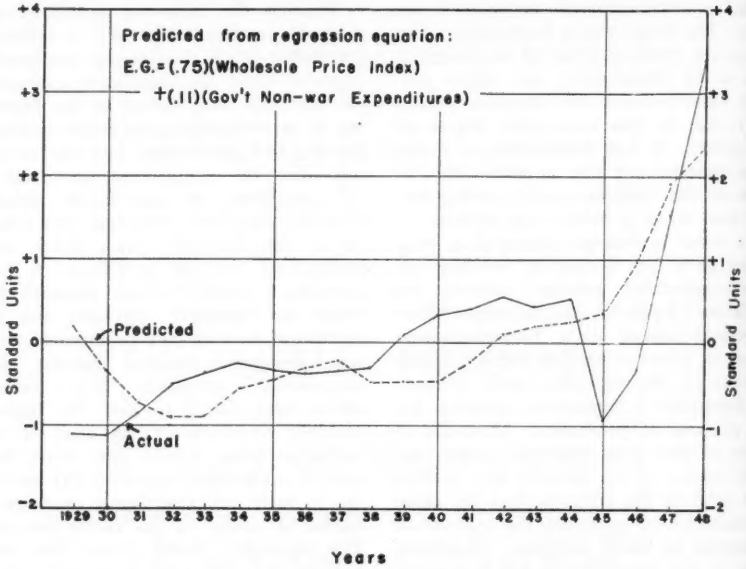

FIG. 2. Engineering graduates—actual and predicted.

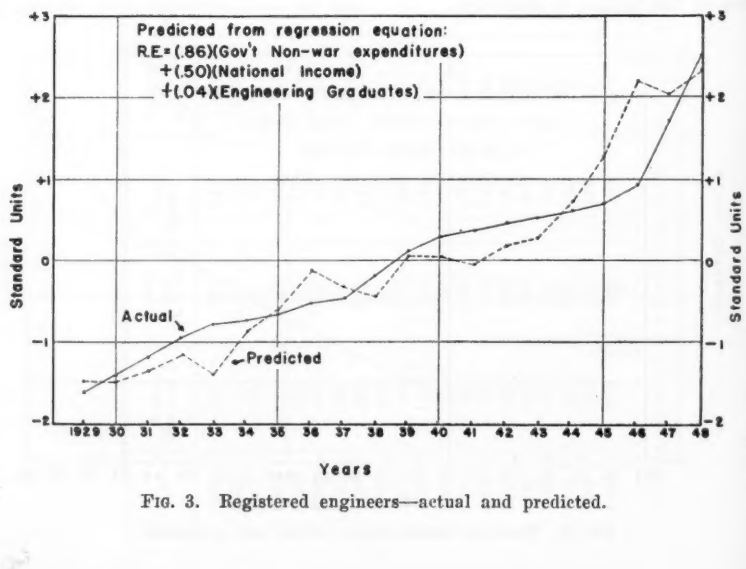

FIG. 3. Registered engineers—actual and predicted.

TABLE 2

Correlation Coefficients

	Retail Store Sales	Total Energy	Wholesale Price Index	National Income	Production Index	Dow-Jones Ave.	Cons. Price Index	Govt. N-W Exp.	Engr. Grad.	Regist. Engr.
Society Members	.91	.90	.93	.76	.75	.31	.94	.75	.70	.87
Retail Store Sales		.93	.83	.86	.81	.42	.83	.72	.50	.82
Total Energy			.89	.91	.92	.64	.86	.66	.61	.85
Wholesale Price Index				.65	.70	.47	.97	.78	.75	.82
National Income					.97	.24	.66	.27	.35	.73
Production Index						.21	.67	.44	.49	.76
Dow-Jones Averages							.54	.13	−.04	.02
Consumer's Price Index								.68	.64	.73
Govt. Non-War Exp.									.70	.86
Engineering Grad.										.82

$$r = \frac{[n \cdot \Sigma XY] - [\Sigma X \cdot \Sigma Y]}{[n \cdot \Sigma X^2 - (\Sigma X)^2]^{\frac{1}{2}}[n \cdot \Sigma Y^2 - (\Sigma Y)^2]^{\frac{1}{2}}}$$

TABLE 3

Significant Variables in Standard Units

Year	Wholesale Price Index	National Income	Consumer's Price Index	Govt. Non-War Exp.	Engr. Grad.	Regist. Engr.	Society Members
1929	.05	−.43	.28	−1.40	−1.09	−1.59	−.51
1930	−.30	−.58	.19	−1.30	−1.12	−1.40	−.47
1931	−.83	−.74	−.33	−1.09	−.81	−1.17	−.40
1932	−1.14	−1.17	−.89	−.63	−.51	−.93	−.44
1933	−1.07	−1.29	−1.12	−.86	−.39	−.77	−.95
1934	−.73	−1.17	−.93	−.29	−.25	−.71	−1.13
1935	−.55	−.99	−.84	−.11	−.32	−.63	−1.13
1936	−.51	−.74	−.79	.31	−.39	−.52	−1.02
1937	−.30	−.60	−.61	.02	−.36	−.41	−.84
1938	−.61	−.60	−.70	−.11	−.32	−.18	−.62
1939	−.64	−.37	−.79	.29	.12	.13	−.44
1940	−.61	−.10	−.70	.10	.39	.33	−.22
1941	−.26	.35	−.51	−.25	.41	.41	0
1942	.20	.86	.05	−.31	.58	.48	.22
1943	.36	1.48	.37	−.57	.44	.56	.44
1944	.39	1.87	.47	−.25	.59	.64	.62
1945	.45	1.81	.61	.48	−.95	.72	.95
1946	1.04	1.11	1.17	1.95	−.34	.95	1.39
1947	2.29	.66	2.10	1.92	1.59	1.74	1.90
1948	2.76	.76	2.62	2.34	3.40	2.37	2.52

Above data calculated by using:

$$Z = \frac{Xi - \bar{X}}{\sigma_{Xi}}; \sigma_{Xi} = \sqrt{\frac{\Sigma(Xi - \bar{X})^2}{n}}$$

TABLE 4

ACTUAL AND PREDICTED SCORES

Year	Society Members		Engr. Graduates		Registered Engrs.	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
1929	−.51	.05	−1.09	.19	−1.59	−1.46
1930	−.47	.01	−1.12	−.36	−1.40	−1.45
1931	−.40	−.49	−.81	−.74	−1.17	−1.34
1932	−.44	−1.04	−.51	−.92	−.93	−1.15
1933	−.95	−1.29	−.39	−.90	−.77	−1.40
1934	−1.13	−1.05	−.25	−.58	−.71	−.84
1935	−1.13	−.94	−.32	−.42	−.63	−.60
1936	−1.02	−.86	−.39	−.35	−.52	−.12
1937	−.84	−.65	−.36	−.22	−.41	−.30
1938	−.62	−.75	−.32	−.47	−.18	−.41
1939	−.44	−.79	.12	−.45	.13	.07
1940	−.22	−.66	.39	−.44	.33	.05
1941	0	−.45	.41	−.23	.41	−.02
1942	.22	.13	.58	.12	.48	.19
1943	.44	.52	.44	.21	.56	.27
1944	.62	.68	.59	.26	.64	.74
1945	.95	.85	−.95	.39	.72	1.28
1946	1.39	1.40	−.34	1.00	.95	2.22
1947	1.90	2.19	1.59	1.93	1.74	2.04
1948	2.52	2.73	3.40	2.33	2.37	2.53
σ =	.30		.69		.40	
R =	.96		.77		1.00	

Above predicted scores calculated from the following regression equations:

Society Members = (.94)(Consumer's Price Index) + (.14)(National Income) + (.07)(Government Non-War Expenditures)

Engineering Graduates = (.75)(Wholesale Price Index) + (.11)(Government Non-War Expenditures)

Registered Engineers = (.86)(Government Non-War Expenditures) + (.50)(National Income) + (.04)(Engineering Graduates)

predicted and actual, warrants a further exploration of the possibility of developing this technique in such manner that the significant independent variables for predicting the number of engineers to be hired can be isolated.

If this possibility is to be explored further, it will be necessary to sample a representative group of industries to determine the number of engineers who have been added to their total personal complement for each specific year covering the period for which the various indices are available.

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Painting and the Graphic Arts*

By STEFAN HIRSCH

Chairman, Art Division, Bard College

The fine arts and engineering may seem at first glance to be apart. One bridge between them, however, is certainly architecture. Although architecture may not be, as has been claimed, the mother of the arts, it is an art, and engineering, even before it was called engineering, has had much to do with it. Indeed some of the best pieces of modern architecture were done by engineers alone, without any pretensions to being "artists" or even architects.

Engineering and Art

As I have never had any working connection with an engineering school, you will have to forgive me for some involuntary over- or under-statements. But I have known quite a number of engineers. Naturally I have known many artists. The mutual contempt in which they hold each other would be quite shocking were we not conscious of the contemporary dichotomy between the sciences and the arts. Allow me for the moment to commit that unpardonable sin: to think of the engineer as an artist. The artist is the man who has the sometimes dangerous ability to sense new meanings in the relationships between man and man, man and nature, man and his ideas, man and art. Can you find any fault in my applying this description at least to the ideal engineer, or even to the physical scientist?

Now to be a man who can perform such revaluation of old relationships in the social, the natural, the ideal, or the artistic spheres, requires imagination. And imagination is as surely the property of every human being as is the intellect. Both can be fashioned into highly acute tools of action. I regret to say that our schools do not concern themselves much with this. Since Descartes, the training of the intellect toward skepticism has tended to destroy the operative unison of imagination and intellect. I am not speaking against Cartesian skepsis in scientific or even philosophic endeavor. I am merely decrying the foolishness of its application to those other fields of human striving, which more rigorously involve the emotional endowments. If you are with me in this, then we have to postulate the development of the imagination, along with that of the intellect of anyone whose work can be identified as an art, irrespective of what scientific tools or disciplines it may employ. The scientific fraternity, I am afraid, has lost the know-how of fostering the imagination during several centuries of naturalism, materialism, positivism. But despite the inroads these philosophies have made even into art education, especially through the art historians, there are still a few artists left, who as teachers understand the problem, and know how to deal with it.

The Cultural Vacuum

Let me get back to the engineers I have met, many of them during our frequent and long sojourns in Latin Amarica. The majority seem to be almost invariably uncultured, socially uphappy people, with time and tequila heavy on their hands, and despised by the population. If they speak Spanish at all, which most of them

* Presented at conference of the English and Humanities Division of the New England Section of the American Society for Engineering Education, Yale University, October 8, 1949.

do not really, even after years in residence, they have failed to learn about those people with whom they work, their politics, their mores, sensibilities and ideals. They never appear to realize how much Latin-American culture is suffused with artistic and other extra-scientific and non-commercial passions, and in the manner of most Americans they choose to disregard it as sissy stuff, never establishing any mutual understanding. British engineers, surprisingly, do much better. But then their humanistic education is infinitely superior to that of our boys.

This is not really surprising. Most of our engineering students go from a humanistically inadequate high school training to a four-year course of highly specialized and humanistically retrenched engineering training, to enter the profession directly. I say "training," because education in the sense of learning how to deal with underlying principles and ideas, except in the mathematical sphere, comes to them not through their curriculum, but only through the accidental presence of a natural-born great teacher. While they master, in a sense, the techniques which represent the fruits of occidental thinking since those proto-scientist-artists Alberti and Leonardo, they have only the vaguest notions of the philosophic and social dilemmas which beset the paths of this thinking, dilemmas which still vex our contemporary scene. In almost all other fields of higher learning it has been found necessary to give the young intellectual workers more than a glimpse of all this. I grant you that, if our high schools were better, we could probably dispense with a few years of higher education. But they are not, and therefore we cannot.

To return for a moment to the Latin American scene: an American artist, residing there for a while, is almost invariably well-treated even if he doesn't speak the language, providing he doesn't go after the girls in too unapproved a fashion. Why is that? I would recommend to you to read the chapter on "The Rich Culture of Mexico" in *The Meeting of East and West* by F. S. C. Northrop, Professor of Philosophy and Law at this very University. It makes amply clear why to the Latin American the artist is *ipso facto* a human being, and the scientist-engineer only if he proves it.

But even within our own gates, the anti-intellectual tenor and the artistically atrophied character of American life, which favors the highly specialized, humanistically telescope training of the technician, makes itself felt in wasteful conflict. On most campuses, hostility between the scientist and the humanist is often but thinly veiled. The philosophers are frequently chosen as mouth-pieces for one side or the other, when they should be the very ones to resolve the conflict. The psychologists lead a schizophrenic life, because they cannot make up their minds where they belong. Even the historians find it difficult. Is this good for the education of our youth? I think not!

By now, I hope I have made some case for more intensive teaching of the humanities, and of the arts as part of them, without having to discuss further the spiritual devastation, brought about in this country, by our obsessive emphasis on the practical, the mechanical, and the inevitably fatal. I would just make this other point: that any person of real vitality, who is allowed to develop only one pole of his field of energy, is only half a man. And it would seem that in this country, and in the coming epoch, we will desperately need whole men, with coördinated intellects and imaginations, in politics, in the sciences, and in the arts. I am, therefore, not even an advocate of the art schools. I would have art taught in colleges, universities, yes, and in engineering schools, because most art schools err precisely in the same direction. They do not attempt to make whole men of their students but technicians and followers of fashions. They do not develop their critical faculties, their understanding of the scientific component of their environment, nor their individual position on the flight-lines of their historical perspective. Like engineers, they are apt

to become narrow specialists. Unlike engineers, the material reward for their narrowness is usually a pittance, and their social influence makes itself felt less widely. Just because the engineer, in more ways than one, is in a key position in the formation of our culture, we would like to see him masterful and whole.

Art for Instruction Engineers

I will now attempt to show how the plastic arts could be introduced. If the study of art should become required, and I do not think that it should, there ought to be a choice of several arts open to the student whose curriculum is otherwise fairly iron-clad. Literature should be there, not only in the guise of English as a tool for the writing of reports; painting, sculpture, and the graphic arts, not purely as decoration or polite pornography; music not just out of an amplifier, as background noise for boring studies or for not-so-boring love-making. They should be offered as sources of enjoyment, as playgrounds for the imagination, as wells of understanding of oneself, of others, of historical periods and of the ideas in other cultures.

I know this sounds fanciful and unrealistic. Yet, it seems to me that many of the feats of engineering sounded much more so when they first appeared in the form of literary or graphic dreams. Cowardice has rarely been the vice of engineers or artists. Just the same, I will abandon this sweeping little dream of mine and speak only of the less inclusive one of painting taught in engineering schools as a matter of course and clear purpose.

Now, contrary to the understanding of science, a sense of art is a highly individual thing, a personal possession, unique to a certain degree in every single case. It is usually there quite amply in childhood, on a subconscious level, when good and evil are not yet clearly distinguished, and before our moral, social, and commercial conventions have corrupted this artistic essence. We must then ascertain with each student, what of this sense of art has remained, to what degree it has been buried under provincial garbage and "corn," and where to let the student start shovelling. How can we do this?

If I were to organize a course in painting at an engineering school, assuming that at least two semesters were available, I would institute one weekly two- or three-hour session for each group of no more than 15 students. They would meet in a well-lighted and not too horrible-looking studio, equipped with the usual paraphernalia and also with a battery of filing cabinets, well-stocked with moderate-sized color reproductions of works of art from the cavemen to Picasso and beyond.

There would be no lectures! Students would start to paint anything they wish: some of the objects around; objects they have brought themselves; things from memory or imagination; things, people, landscapes, ornaments, abstractions, dream symbols; in short, anything their fancy turns to. And of course in any medium they choose, even in pencil. Speaking of pencils—engineering students must be fed to the teeth with them. They could forget them for a while in this course, forget security to go out on adventure. Moreover, drawing may be basic, but it is not elementary to painting; painting is the elementary discipline of painting. Draftsmanship will be developed through it by and by. So will perspective, anatomy and all the other blandishments of tradition, if indeed they be needed. It is like the case of calculus, which is one of the basic disciplines of engineering. I don't believe it is given anywhere as an elementary math course. Too difficult? Well, drawing is equally too difficult when the imagination is to be stimulated and let loose again for the first time in 15 years.

Remember: we are not trying to produce great draftsmen or even painters but imaginative engineers. Still, whoever insists on pencils, those great little tools of abstraction, may have them. No doctrinaire inhibitions! Whatever little flight of the imagination, it must be done on the student's own wings.

Criticism of the work should consist, not in telling the student what is wrong, but in making him tell us. When he arrives at that point, we select from the cabinets a master's painting which deals more or less with the same problem as the student's job. Again, there should be no lecture, but a guided discussion helping the student to see the analogy. This may be followed by certain technical suggestions, if possible some alternative procedure, which would give him the responsibility of choice, with or without thought. He'll learn soon enough to think and to imagine, before acting.

The second session of the course would be entirely devoted to critical and historical work on the basis of the study of reproductions and of assigned readings. There would be no lectures and no textbooks, but discussions and an adequate choice of pertinent books in the library. Not a survey course in the history of art, skimming over the surface of chronological facts and appearances, it would be work in depth. Remember? We don't want to train art critics. We want to cultivate the imagination of engineers. They would first learn conscientiously to observe paintings, all of each painting. They would not be encouraged to blow off steam about their likes and dislikes, indicating only their own previous state of servitude and nothing about the picture. Close study will soon reveal to them their own capacity to feel things more deeply than at first glance. Or as Schopenhauer put it rather neatly: "Before a work of art you should act as though you were in front of royalty; you don't speak until you are spoken to; or else you might just hear the braying of an ass." Gradually they would be induced to think about the interrelated form and content of works of art, to read about them and to write down what they have observed, felt, and read.

The studio sessions would alternate, weekly, with the critical seminars. In these workshops the student's artistic endowments would be explored by him and by the instructor, and developed in the most individualistic mode possible. Since great talent cannot be expected of the average student, we would not stress too much the professional perfection of his artistic accomplishments while grading his work. Instead more attention should be paid to the artistic insights he has gained, the adaptations of technical proficiency to creative aims, no matter how simple. It is impossible to describe meaningfully the further growth of this part of the course because it must concern itself with individual cases in which anything can happen, from the dead level of convention to little miracles.

The critical studies which can be rated along more established lines would progress from the discussion of individual masterpieces to comparison of works with similar subject matter, but by artists of different periods. This would slowly clarify the historical fact that man's protean poetic imagination implements him equally with protean technical imagination, and that each culture, each epoch, each group and each individual leaves behind art products whose forms reveal the general content of the feeling and thought of those who made them. Reading would be assigned to illuminate not only the esthetic considerations, but the cultural backgrounds in the broadest sense. Finally a definite period of art could be studied, applying all the techniques of investigation previously learned, to afford a glimpse into the dynamics of history and the vastness of man's aspirations. From the art historian's point of view this might appear a superficial course. But we don't want to train art historians. We want to open a window on Parnassus for engineers.

I could now continue to finer points, talk about the therapeutic values of art because of its ability to create from dream and play elements something which is socially communicable and therefore eminently practical, and things of that sort. But, ladies and gentlemen, there is nothing of immediate practicability in this plan, except that an engineer, sensitive to

human values, while not therefore a better technologist, is apt to be a better specimen to let loose on other humans. There can be no guarantee of greater earning power for the engineer who happens to know that one of the greatest artists of our time and hemisphere, Orozco, died a few weeks ago; or who understands that Picasso is neither insane nor a fake; or why Michael Angelo could not have been a member in good standing of the Lions' Club. But in almost all parts of the world, people care to do business not necessarily with the man whose price is the lowest, but with a man they like. And they like people who understand their modes of living and who appreciate things beyond the job and the dollar.

To understand a work of art requires a mixture of uncompromising alertness and self-respecting humility. To create a work of art, more than almost any other academic discipline demands direct action, after clear-cut decision, based on intellectual as well as emotional motivations. In other words, it involves the whole personality and requires from it what we demand of the good citizen: Heart, Wisdom, Devotion. If these are not the qualities you want to see even in engineers, don't let them study art.

Sections and Branches

The annual meeting of the **Michigan Section** was held on May 20, 1950 at Wayne University in Detroit. Speakers at the meeting included the President of Wayne University, D. D. Henry, L. G. Miller, A. R. Carr and A. R. Hellwarth, who spoke on "The Employment Opportunities for Engineers in Small Businesses." The following slate of candidates for officers was presented and manimously accepted: Chairman, H. M. Dent; Vice-Chairman, W. P. Godfrey; Secretary-Treasurer, F. L. Schwartz; Representative on General Council, L. G. Miller.

The **National Capital Area Section** held its meeting on May 6, 1950 at the University of Maryland. H. H. Armsby, Vice President of the ASEE presided. The program included a discussion on "The Improvement of Engineering Teaching." Officers elected included: Chairman, R. B. Allen; Vice-Chairman, W. Oncken; Secretary-Treasurer, L. K. Downing; Representative on the General Council, R. S. Glasgow.

The sixteenth annual meeting of the **Southeastern Section** took place at Roanoke and Blacksburg, Virginia with the Virginia Polytechnic Institute as host on April 20, 21, 22, 1950. E. B. Norris introduced L. F. Livingston, of E. I. du Pont de Nemours and Company, who addressed the group on "Progress in Better Living." Other speakers included T. C. Brown, M. I. Mantell, D. H. Pletta, L. R. Quarles, J. D. Fuller, F. C. Vilbrandt, A. T. Granger, W. F. Gray, J. H. Sams, and F. J. Lewis. The following officers were elected: Chairman, E. B. Norris; Vice-Chairman, R. L. Sumwalt; Secretary-Treasurer, B. Bayer; Representative on the General Council, C. R. Vail.

Music and Engineers*

By KLAUS LIEPMANN

Assistant Professor and Director of Music, Massachusetts Institute of Technology

Our concern this afternoon is with the future scientists and engineers whose interest in music is greater than can usually be satisfied during their study years. The notion that music is more or less a queer, merely emotional, effeminate, or, as some people say, purely sensual preoccupation for a few gifted people—a specialty for "musical" students only, whatever the word "musical" means—that notion needs revision. One has only to remember that many great scientists, mathematicians, medical men are ardent and active music lovers. These men are used to substantial and prolonged concentration and to the combination of physical and spiritual values. Any recreation which would consist of hazy daydreaming would never interest them for any length of time.

Music is a language expressing human thoughts, human aspirations, fears, and hopes through the Ages in organized and concentrated form. You may call it a combination of imagination and higher mathematics. Because it is universally and eternally human, it is a language open to everyone and all. To say, "I don't like music," is as senseless as saying, "I don't like trees." To say, "I don't understand music," is no more than admitting, "I cannot follow the groping of science for the mysteries of the universe." Being puzzled by music need not be more alarming than being involved in the endless search for an explanation of man's behavior, his actions, and his ideas about the state of life and death.

The only trouble with this language of music is that it cannot be translated. An artist chooses his own medium, and if the message contained in a piece of music could be better or more convincingly expressed in a painting or in poetry, the composer would not say what he has to say in music. There are, of course, basic similarities in the main thoughts and problems presented during any particular period of history by its fine arts, its music, its literature, its philosophy. To a certain degree the art of the Renaissance will throw light on its music, and vice versa. These correlations, however, will serve no better than a simile, for eventually the art of music has to be dealt with on its own terms, that is, with the stuff, the logic, the impact of music itself.

Music and the Humanities

Now if we can agree on the importance of music as a link in the chain of the humanities, as a thing in itself, and ever-present throughout History, there remains the question how to keep music alive and strong in our engineering institutions. I believe that there are three avenues open, at least to engineering schools, and the problem is constantly to improve "traffic" on these avenues.

I should put as first in importance the creation of a musical environment. I believe that a technological school should include among its books the serious biographies of the great composers, music encyclopedias, histories of music, together with books of English literature, history, fine arts, fiction, etc. I would avoid the purchase of popularized books on music or composers. The chatty type of writers

* Given at the conference of the English and Humanities Division of the New England Section of the American Society for Engineering Education, Yale University, October 8, 1949.

on music, trained in women's clubs lectures and the suave radio commentators have driven away scores of potential music lovers rather than brought them nearer to music.

I also think that opportunities to listen to records in a quiet room should be made available to students. A comprehensive record library requires, of course, considerable money, space and personnel. A beginning can always be made, however, in acquiring a basic record library which will in a short time contain representative works of the literature of music, including samples of all types of music: Folk-music, songs and Lieder, chambermusic, symphonic works, choral works, opera.

Of great help to the phonograph listener will be the availability of pocket-size full scores for chambermusic and symphonic works, and of piano scores for songs and operas. Even for those who cannot follow a score (and very few really can) occasional attempts in that direction will help to convey the structure of the music heard. Music has the disadvantage from the point of view of the analyst or serious student in that it does not stand still, but flows on at its own tempo. Repeated hearing helps in grasping more details and the over-all structure. Yet still better is the study of the blueprint of a piece of music before and while hearing it. A score is the musical equivalent of an architectural blueprint and, like an amateur architect, a student of music can make out certain features from the score.

Finally, in creating a musical environment I would suggest arrangements for more or less formal concerts of *live* music in the school itself. No matter how many occasions the city or town may offer for attending outside concerts, a string quartet, a good singer, or instrumentalist, or one of the small traveling opera companies offered by the school in its auditorium or lecture hall convince students more than anything else that broad cultural interests including music are needed in order to become a good scientist or engineer, or administrator, or architect, and that a technological school practices what it preaches along these lines.

Music as Recreation

Extracurricular activities are the second avenue of approach towards music for the engineer. You would never believe how much enthusiasm, talent and skill exists among young Americans, especially among those whose mental curiosity and searching minds drive them to study science and engineering, until you have given them ample opportunities to make music in their free time. Of all students at least ten per cent (and unfailingly this group recruits itself from the fifteen per cent with the best all around marks) bring a remarkable training in the singing and playing of music to their secondary school. It is felt that a college or university should at least do what every high school of the country does—provide musical instruments for band and orchestra, and furnish sheet music, rehearsal rooms, pianos, and professional "coaches" for music. Too often I have heard it said that "there is so little time for extracurricular music that a little fun and enthusiastic, if incompetent, leadership is all that is needed here."

I think, rather, that one should argue like this: "Just because our students do not get enough of the humanities in their curriculum, the extracurricular activities must be considered an important educational factor. Therefore, in order to make the best use of the little available time, and also because these students are used to experts in aerodynamics, etc. let's get a specialist in music if we want to give them music at all."

Incidentally, the recreational aspect of extracurricular music is frequently sadly neglected because one assumes that fun and recreation are incompatible with concentration and hard work. While it is granted that athletic activities, demanding the last ounce of energy from the participants, are healthful; and that concentration in playing chess, and sweat in building a boat or a cabin are fun—in

music one frequently takes dabbling in Gilbert and Sullivan or reclining on a couch and reading a magazine while listening to the radio or phonograph for the happiest state of enjoyment and recreation. I would rather claim that the straining of one's concentration and energy in singing Bach Cantatas or Handel's *Messiah* or the integration of many orchestra players in giving a creditable performance of Beethoven's early symphonies is the healthiest mental and physical recreational occupation for those whose studies and professional training tend towards scientific specialization.

It should not be forgotten that it is an important social boost for engineering students to be able to join liberal arts girls' colleges in singing and playing the world's greatest choral and orchestral music. The greatest benefit, however, to be derived from hard work in preparing concerts lies, I believe, in the fact that students "rub shoulders" with great men when they prepare a program of classical or contemporary music. They become intimately acquainted with the thoughts and feelings of the masters when they try to conquer their music, and will truly appreciate a professional interpretation ever after.

Curricular Arrangements

Finally, I think there should be a place for music in the curriculum of a technological school. While I know that there are other engineering schools which offer courses in music, I am only familiar with the situation at M. I. T. Therefore, I will tell you about the music course there. In the curriculum of a Technology student there is only a limited time left for the humanities, approximately one fifth of his total curriculum hours. The first year will usually be devoted to English. The second year might include history, the third year social sciences with perhaps a choice in the second semester of psychology, labor relations, or industrial economics. Finally, in the senior year there is time for electives: international relations, history of ideas, books and men, and *music*.

The course in music at M. I. T. consists of three weekly lectures and five hours of preparation on the part of the student each week. It carries eight points of credit for each semester. The exact title of the course is "Introduction to Music" for the first semester and "Music Through the Ages" for the second semester. I will quote here the description of the two courses as it appears in the catalogue:

E 45. Introduction to Music. Designed to make students more familiar with the language of music and its universal literature including contemporary music. Rudiments of harmony and ear-training, and an outline of the terminology and history of music. Detailed analysis of masterpieces by various composers through lectures, demonstrations, and outside listenings. Reading assignments required. For students with little or no knowledge of music.

E 46. Music Through the Ages. Survey of the history of music with emphasis on musical examples from the Middle Ages, the Renaissance, the Baroque, and the Classic Era. Detailed analysis of the master works of Bach, Mozart, Beethoven. The Romantic Age and contemporary music, as well as a short historical analysis of opera. Lectures, demonstrations, outside listenings, and reading assignments.

Our textbook is "What to Listen for in Music" by Aaron Copland,† a concise description of the elements of music presented from the point of view of a prominent American composer. In addition we use an elementary music theory writing book which acquaints our students with the symbols of music, fundamental rhythm, melody and harmony as encountered in any better music analysis or commentary lecture.

By far the most part of the students' preparation is spent in listening *repeatedly* to a list of assigned phonograph records which are played for groups at stated hours or can be listened to individually through earphones. The list of

† Whittlesey House, McGraw-Hill Book Co., Inc., 1939.

music is selected so that there may be music of all times, allowing for examples of rhythmic, melodic, and harmonic application and building towards a rather inclusive picture of the world literature of music.

Obviously, the purpose of any music course of an introductory nature is to help students to become more discriminating and intelligent listeners. The customary procedure of reciting the lives and loves of composers is of little avail. The creation of art is influenced and motivated by deeper currents than the daily life experience of the composer. Tradition, currents of thought, vision, and the specific behavior of the material at hand all go into the making of worthwhile music. It helps little or nothing towards grasping some of the essentials of Bach's B minor Mass, for instance, to know that he had twenty children. Instead one rather studies the sources of the Lutheran chorale which lie in the Gregorian Chant and in popular Folksongs, the constructive and ecclesiastical evolution of Polyphony, the development of the Catholic Mass, Bach's attitude towards the pietists, and so on. Similarly, Beethoven's symphonies are not brought nearer to the listener by anecdotes dealing with his bad manners or his unhappy love life. Instead, an observation of the development of the classical symphony as a form, his rhythmic and harmonic innovations, and his being a musical messenger of the French Revolution, although perhaps less colorful in immediate appeal, lead more directly into the very heart of the musical matter. The set-up of a society at a given era in history, the status of the musical instruments available, the tonal and structural preoccupation of a group of musicians, the changing of the relations between church and state—all this goes into the making of worthwhile music.

While the first semester of the course is devoted to the fundamentals of musical grammar, to a detailed discussion of the elements of music, rhythm, melody, harmony, tone color, and its structural form, the remainder of the year brings a detailed analysis of musical masterpieces of the past and present. Mimeographed program notes, slides, diagrams of structure and illustrations at the piano are used continuously in class. Frequent performances of live music by professional musicians living in the Boston area supplement the musical food of the students which would lack "vitamins" if it were limited to "canned music" alone.

I am glad to say that our music course at M. I. T. is known as a stiff course. Although requiring no previous training or experience in music, yet it demands concentration and much active preparation and cooperation on the part of the student. There are quizzes—and students have flunked the course.

At present the course is taken by 233 seniors out of a class of 1057. It is held in two sections and requires the constant use of a considerable record library and a piano during lectures. This set-up requires considerable financing—it is helpful, though, to remember that physicists and chemists need laboratory equipment and are not accused of wasting their time during laboratory periods. Similarly, the occupation with music requires that time and money for equipment be spent in a "musical laboratory" and, although there may be little time and space for music in an instituiton, what little there is should be of the best. No matter how elementary the initial presentation, when dealing with Technology seniors, the instructor in music will find himself thrown into a discussion of complicated twelve tone theories or contradictions in the traditional musical concept of harmony whenever and wherever questions have been encouraged. There is no alibi for the music instructor in a Technological school by way of saying, "For this you need first two years of harmony and counterpoint." Nor is it acceptable to describe great music in merely aesthetic and fashionable terms. Nowadays, we hear men like President Conant of Harvard advocate that every Liberal Arts curriculum should include a course in the

History and in the Principles of Science; I would like to submit the proposal that the Engineering Curriculum should acquaint the technology students with the history and basic structure and content of music through the ages.

Conclusions

In conclusion, let me say that I do not really belong to the group of people who claim music as a cure-all for the world and its struggling citizens. No one will claim that the atom bomb is the solution for the evils of the world. However, we must try not to go too far in the opposite direction by asserting that music can be the solution for everything. It does not follow from the fact that in Berlin there are now five opera companies producing operas every day in the week as compared with two opera companies operating in New York City that the German people have made any progress toward a more democratic and peace-loving attitude. Yet I do believe that the total absence of music education and musical activity in our various secondary schools would amount to illiteracy in an important field for which there is no substitute.

Let me stress again that I have spoken of music at M. I. T. because I am not familiar with music in other technological schools. I am sure, however, that much is being done elsewhere and I am firmly convinced that whatever is being done in music depends upon the attitude and imagination of the administration, the various deans, and the department heads.

The Cam Motion Indicator—A New Teaching Aid

By JAY SCHEINMAN

Lecturer in Engineering Design, University of California

There has been a long-felt need in the field of Engineering Education for effective demonstration models to supplement lecture material presented to students in connection with various basic theoretical courses.

One fulfillment of this general need has been the recent development of a "Cam Motion Indicator," used with college classes in Engineering Kinematics to illustrate the motions of cam mechanisms. This machine, designed and constructed on the campus of the University of California at Berkeley, is capable of illustrating a variety of cam motions with different types of followers, and will automatically plot a displacement-time diagram by the mere manual turning of a crank!

The name of the device—"Cam Motion Indicator"—is of dual significance: there is indication of physical motion by the very movement of the component parts of the mechanism, and these movements are translated into mathematical terms through the plotting of the displacement-time curve which the machine automatically accomplishes.

As shown in Fig. 1, the Cam Indicator consists essentially of a supported wooden panel on which are mounted a steel cam, steel follower in brass guides, and movable plotting board. The cam, when manually rotated by means of its attached handle, will cause the follower to rise and fall in a vertical path. A ball-point pen, inserted in the body of the follower and held under spring tension, will then automatically describe a continuous displacement curve on the plotting board while the latter is being translated horizontally by the action of a train of gears mounted on the rear of the panel (see Fig. 2). The lead gear of this train is keyed to the cam shaft and the follower gear engages with a rack attached to the movable plotting board. Thus two basic forms of motion, rectilinear translation on the part of the cam follower, and angular rotation by the cam, are "harnessed" by the mechanism and are graphically delineated through the automatically-plotted cam diagram. The mechanism will further illustrate the effect of cam pressure angle on the body of the follower and its guide bearings.

Since the type of follower motion is controlled by the cam profile, innumerable forms of motion are made possible by differently shaped cams. The particular shape of cam surface employed in the Cam Indicator will produce four forms of follower motion based on fundamental mathematical laws, namely:

a. Harmonic Motion
b. Dwell
c. Combination Uniform Motion
d. Constantly accelerated and retarded motion

The relative characteristics of these specific motions may be observed by a study of the drawing attached to the model shown in Fig. 1, and are summarized in the following table:

Nature of Motion	Follower-Displacement (D) vs. Cam Position (θ)	Type of Motion Curve	Velocity	Acceleration	Starting Force
Harmonic	$D \sim \sin \theta$ ($\sin t$)	Sine curve	Variable	Variable	Large
Uniform	$D \sim \theta (t)$	Straight line	Constant	θ (discontinuous at start and stop)	Very large
C.A.R.M.	$D \sim \theta^2$ (t^2)	Parabolic	Variable	Constant	Small
Dwell	No vertical displacement of follower as cam rotates				

Although the particular plate cam used with the indicator will produce only the aforementioned follower motions, the follower itself provides a greater flexibility of performance, as it has been ground to a point at one end and contains a roller bearing at the other. By simply inverting the follower in its guides the relative advantages of sliding versus rolling contact may be quickly and effectively demonstrated. In addition, the construction of the panel board permits a change of position of the follower and its guide with respect to the cam axis, converting the system from an offset-follower-cam arrangement to one of alignment. This latter change is quite easily accomplished by simply lifting the follower and its guides out of the panel grooves provided for the offset position, and placing these parts into parallel "alignment grooves." Figs. 1 and 2 illustrate the construction quite clearly.

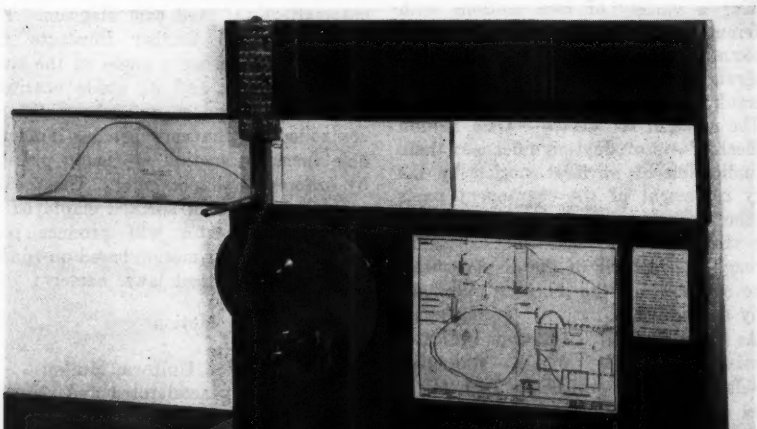

FIG. 1.

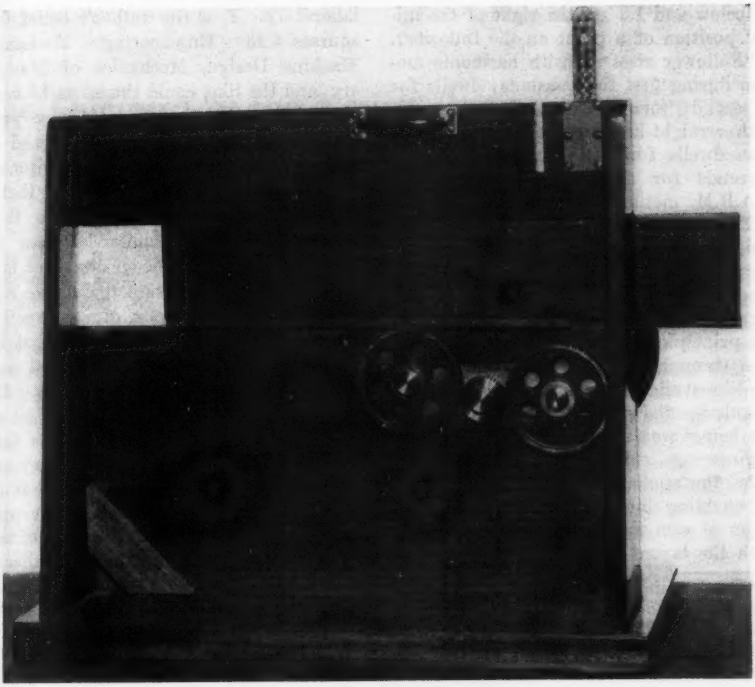

FIG. 2.

Sufficient versatility has been incorporated in the construction of the Cam Motion Indicator to permit replacement of the plate cam by cams of alternate shape, thereby enabling this mechanism to plot an infinite variety of displacement curves by such simple substitution, using either the pointed or roller follower in its aligned or offset position. In this manner a fairly wide assortment of performances may be achieved by the model.

It will be observed that space has been provided on the face of the panel board for the mounting of a drawing which illustrates the geometry of the plate cam design, and shows the plotted velocity and acceleration motion curves which are, of course, the first and second derivatives, respectively, of the displacement curve. (As a laboratory exercise, these derived curves may be readily plotted by the student through application of the principles of the Graphical Calculus.) The drawing further shows the relative values of pressure angles determined at various points along the cam's lateral surface; the specified direction of cam rotation; and it also records nomenclature and terminology pertinent to cam theory and design.

One design problem on which the plate cam of the Indicator has been based is also attached to the panel board in statement form. For the convenience of the reader, this problem is quoted herewith:

"A plate cam revolves in a counterclockwise direction at the rate of 5 R.P.M., transmitting the following motion to a pointed follower whose path is a vertical line: (The cam axis is offset

2" below and 1.3" to the right of the initial position of a point on the follower).

"Follower rises 4" with harmonic motion during first four seconds; dwells for 1 second; then drops 2" in 2 seconds with straight-line combination motion *; then dwells for one second; and finally descends for the last 4 seconds with C.A.R.M. motion to the starting point."

The Cam Motion Indicator possesses considerable course adaptability. As mentioned in the opening paragraphs of this paper, the model serves primarily to supplement a theoretical discussion of the principles of cam design and application through its use as a demonstration model—available laboratory equipment to enhance the study of technical mechanics being woefully inadequate in many engineering colleges. It further provides the student with a tangible means of enabling him to crystallize his concepts of cam mechanisms as he proceeds with the layout of such problems in the laboratory. It is the author's belief that courses in Engineering Mechanics, Machine Design, Mechanics of Machinery, and the like, could therefore be made more interesting, be given a more practical trend, and otherwise enlivened by the use of such demonstration equipment.

In conclusion, it would seem that a few words might be helpful to those planning to build similar devices for their own use. The model described is of sufficiently simple design to involve relatively low cost and ease of construction. Yet it must be borne in mind that the mechanism is intended to be used as a demonstration model exclusively. Extreme accuracy of performance is not only difficult to obtain within the feasible limits of material, time, money and effort, but is actually unwarranted if the machine is to serve its intended purpose. As a teaching aid, however, it is firmly believed that the Cam Motion Indicator will prove to be, in its own specialized way, a valuable adjunct to a more significant engineering education.

* Straight-line combination motion is modified uniform motion to avoid abrupt starting and stopping of the follower.

The Dilemma of the Young Engineering Teacher

By CARL M. COOPER and J. W. DONNELL

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The young man who intends to become a teacher of engineering today is faced with the problem of planning his preparation for such a career. One of his first problems is to decide how much formal education to acquire and whether or not to obtain actual engineering experience in industry. Obviously his first step is to obtain a bachelor's degree in engineering as this is basic either for a job of engineering in industry or for further progress in academic fields. The first question then is what to do after securing the first degree—whether to get out and get a job and thus put to the acid test of actual plant operation all this knowledge he has acquired or whether to continue in school working toward higher degrees, and picking up a little teaching as he goes along.

The Academic Route

There are advantages to the prospective young teacher in taking the academic route, that is in beginning immediately to study for the Ph.D. degree after having obtained his bachelor's degree, without having had any actual engineering experience in industry. One of the advantages is the relative cheapness of this route. Only three nine-month periods are usually required for the Ph.D. degree beyond that required for the bachelor's degree. Moreover in most cases the student's expenses can be reduced by summer work, and the plan partly financed by work of a teaching nature along with the graduate work. However, it is true that should too heavy a teaching load be attempted while doing graduate work the time required for the degree will be extended. Contributing also to the economy of this route is the fact that the student's standard of living is considerably lower than living standards in industry so that if he continues in school without interruption, his financial outlay will be considerably less than it would be if he entered industry and then returned to school. Another advantage, which is of no small consequence, is the ability of the young man who continues in school to understand readily what is desired of him in his classes. If he has continued the business of going to school from the primary grades on to his Ph.D. degree without a serious interruption, he realizes what is required of him by his teachers. This advantage shows itself particularly well if we compare two students working for the Ph.D degree, one of whom has never had a break between the bachelor's degree and the graduate work while the other has come in from industry. The latter finds it rather difficult to know exactly what is expected of him. In other words, he has lost the knack of the teacher-student relationship which he knew well during his undergraduate days and this is a serious handicap.

Moreover, if one follows the academic route, he will not be subjected to the radical changes in his way of life involved in moving from school work to industry and back for he will, in a way, be following the same kind of work he began as a child. The radical change from school work to industry has been a decided stumbling block in the career of many a man. Finally there is the recognition which the possession of the Ph.D.

degree gives among college associates and college administrators. Nowadays a Ph.D. degree can be looked upon pretty much as the teacher's union card without which, among most college administrators, it is virtually impossible to hold down a responsible position. One can easily see the reason for this attitude on the part of college administrators in the lack of other means of gauging a teacher's ability. Teaching ability and teaching effectiveness are hard to evaluate and degrees are tangible.

Along with the advantages of the academic route there are some disadvantages to the young teacher. It has been stated that no one can speak with any authority on engineering subjects unless he has obtained some industrial engineering experience. This is perhaps too strong a statement. Nevertheless, it does have some element of truth in it. Perhaps a better way of stating it is to say that the teacher with no engineering experience has no way of knowing what particular fundamentals to stress in his teaching. For example, the young teacher may go into rather elaborate calculations regarding a heat exchanger without any mention of the fouling factor which the design engineer in industry must put on in a design calculation if he is to have a satisfactory design while in most cases this fouling factor offers more resistance to flow of heat than all other factors combined.

The effect of this lack of first-hand knowledge was evident recently in a conversation with a colleague. A large boiler had recently been installed in the local community power house and in describing the size of the boiler a newspaper account stated that it was 120 ft. tall and had a drum 60 ft. in diameter. Our colleague remarked, upon being told of this description, that he did not know whether this was out of line or not, even though the pressure on the boiler was, as he knew, some 900 pounds per square inch. The young teacher without industrial experience cannot know what particular fundamentals to emphasize more than others. His only guides are his teachers or his books, and books are sometimes written by people no more experienced than he. Yet one must remember that he is called upon to prepare a product for industry, since at least 80% of his product goes into industry. We are not suggesting a trade school but are not engineering fundamentals necessary if we are to continue as Engineering Schools? Another serious disadvantage offered by the academic route is the grave psychological effect on the teacher of dealing continuously with immature minds, of never having to deal with his equals. Students know that they must please their teachers, or low grades may result; and this is bad for the teachers ego. One of the fundamentals upon which business in this country is based is competition and, we all recognize that competition makes better products; yet this is the very thing that the school teacher who follows the academic route exclusively never experiences.

Lack of first-hand knowledge of the needs of industry affects the young teacher's work in another way. Not having pertinent problems of his own for his students he is likely to resort to a series of small problems of little value, but which offer something for the student to exercise his mental powers upon. In this way the course sometimes degenerates into an exercise in mental gymnastics.

The Industrial Route

It is clear that the advantages to the young teacher of following the academic route far outweigh the disadvantages. Now what happens if he chooses to enter industry after receiving his bachelor's degree? The first and most obvious gain for him is that of getting first-hand knowledge. A second advantage which comes to the young man who elects industry is the gain in tolerance, cooperation, and humility, by-products of his job and traits much needed by the teacher. In industry one works closely with his equals and his superiors as well as with

his inferiors. If he cannot or will not cooperate, he does not last long in industry. His mistakes and failures, unlike those in teaching, are visible and tangible, and through them he learns humility and tolerance for the mistakes and failures of others.

One of the very first things that the young engineer learns on getting out into industry is that he must sell himself to his superiors. His employers do not take it for granted that, because he has the scholastic training required for his job he can do the job. This he has to prove. Some of the most successful engineers that we know spend as much as half their time selling their wares to their superiors. A teacher who has had this industrial experience can use it to advantage in his teaching. We all recognize the lack of this ability among students, and we have made some attempts to correct it by having them write decent reports and make decent practice speeches. Here the experienced engineer has a decided advantage over the inexperienced one because any engineering student will resist good report writing as well as good speech making unless he is given a good sound reason why it is necessary in his profession.

The experience route then, offers some advantage to our young teacher, but it has disadvantages too. The engineer from industry who turns teacher may find himself in trouble at once. He may know his subject but it is another thing to get it across to the students. In industry he has been dealing with mature minds, and he overestimates the student's ability and overloads him by giving him problems which are too long or which require judgment which the student lacks through immaturity or inexperience. Problems that are filled with practical assumptions if not carefully watched tend to confuse the student, accustomed as he is to neat problems with definite answers. Another disadvantage of the experience route is that if the young engineer knows that he is ultimately going to become a teacher, he may never pay much attention to his work in industry, but touch only on the outer fringes of the profession because he does not intend to make a career of it. Therefore, he may never truly see engineering work. There is, of course, another type of engineer one who has made a success in industry and then turns to teaching not having previously planned to teach. Sometimes such a teacher intends to retire to teaching, but teaching is not a profession to which one can retire. Young, immature minds expect enthusiasm and action and will not tolerate the type of person who is "retiring" to teaching. Another serious disadvantage of the experience route lies in the possible loss of technical ability. It has been stated that nine out of every ten engineers who go into industry have within ten years passed from technical work into executive work. As an executive it is difficult to find time to keep up with the new technical advances and thus if the young engineer intends to teach he shouldn't remain too long in industry. Still another type of engineer plans to go into teaching after leaving industry but is unwilling to live on a teacher's salary and expects to augment his pay by consulting. Certainly if he is going to live on the scale to which he is accustomed, if he has been a success in industry, he must augment his teaching salary. But therein lies a very great danger. Teaching is a full-time job and teaching can very easily be neglected if one takes on too much consulting.

Combination of Academic and Industrial Routes

A proper combination of academic achievement and industrial experience would seem to be the ideal course for the young teacher of engineering, but such a combination is expensive and time consuming and would mean adjustment and readjustment for the young teacher.

Just when and how the young man, who elects industry after his bachelor's degree and later returns to teach, is to se-

cure his advanced degrees is a problem. If he takes time off to secure them, he must find money for some three years without income. If he teaches as he studies, it will take longer than three years, and his scale of living will necessarily be lower than when he was industry. If he was successful in industry and can return to it, he will be sorely tempted to do so.

On the other hand, will the young man who continued in school through his Ph.D. degree then leave the school room for industrial training? More and more the answer is, "no." He is used to the academic pace and generally dislikes the faster pace of industry and resents its discipline and its lack of deference to his scholarly attainments. We live in a time in which security is valued above all else. The days when a young man sought the difficult or the adventurous path to prove his mettle have gone. Accordingly when the young would-be teacher has won his doctor's degree, he will not, as a rule, willingly venture forth from the security of the academic elms where the mere possession of his degrees is sometimes accepted as evidence that he is and will be adequate to any demands made upon him.

Since some 80% of our young engineers go into industry, is it not fair to assume that industry should have something to say about how their young engineers should be trained? Some companies not only make this assumption but also state that college professors do not know what is required in industry. As a result at least one company, namely the Monsanto Chemical Company, has agreed to take a certain number of young professors into their plant for a year each to acquaint them more thoroughly with what they demand of engineering graduates, with the understanding, of course, that they will return to their colleges and impart this knowledge to their students.

Before leaving the question of a combination of the two routes, it might be well to look into the European educational system which also is practiced in South America. In this system industry works very closely with colleges and universities supplying them with some of their executives who do part-time teaching and part-time industrial work and in most cases a heavy exchange of professional engineers is carried out. This system would appear to be an ideal system and there has been a tendency in this country to turn to these methods as indicated by the Monsanto Chemical Company's plan as well as plans of some others like Westinghouse and General Electric. However, it is unlikely that this type of training will soon become sufficiently prevalent for the young teacher to depend upon.

The cooperative colleges have solved the problem in their own way, and there is talk that some engineering schools plan to make at least a year of industrial experience a prerequisite for admittance to candidacy for the doctor's degree.

Enlarged research programs which would include all our teachers would help if the money could be found for the projects, and teaching schedules adjusted to permit participation by all our faculty members.

At any rate the dilemma seems, after all, to be that of the engineering schools.

Who Is Responsible for the Placement of the Graduate?*

By W. C. VAN DYCK

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Introduction

The placement of the engineering graduate from the standpoint of the student, the college staff, and industry presents a complex series of related problems. The general purpose of this discussion will be to describe these problems with suggestions for solutions.

There has been a marked shift in the responsibility for the placement of students at most larger colleges and universities during the last ten or fifteen years. Industrial Personnel men often wrote individually to the Head of each college department if they wished to interview Mechanical, Electrical and Civil Engineers on the same campus. This arrangement was awkward and time consuming. In the interests of efficiency a change was inevitable. So, in most cases, the position of Placement Director was instituted. This coordinator is now responsible for arranging interview schedules for all college departments with industrial representatives. This centering of responsibility in one office and one person has enabled the interviewer to talk with a greater number of students of varied educational backgrounds, in a shorter length of time, and with fewer preliminary arrangements.

This shifting of responsibility has improved efficiency, but in most cases it has resulted in a corresponding lessening in the personal contacts between industrial and business representatives and members of college staffs. At universities where there is a placement director, the industrial representative seldom meets individual Department Heads unless he asks to. That close personal relationship between the man who teaches the students and the man who hires the graduate may be losing ground.

I often wonder if many professors and Department Heads don't feel that a burden has been lifted from their shoulders when a placement director takes charge. Yet, most placement directors agree they do not have a close enough contact with each individual student to counsel him on placement matters. The purpose of this discussion is to suggest who should carry a large portion of the responsibility for the placement of the graduate regardless of the organizational arrangement.

It may appear that the writer, being in industry, is a little presumptuous in suggesting to you what your responsibilities as college men may be. However, in the writer's contacts with students at campus interviews and in supervising young graduates in industry, certain basic fundamentals kept coming back again and again. These thoughts are presented here for you to evaluate as you will. They are proposed as ideas for your consideration. The hypothesis taken is that the most important part in the proper placement procedure comes before the job interview and perhaps before the senior year.

Who is Responsible?

Almost every interviewer asks the student during employment discussions,

*Presented at the Missouri Section of A.S.E.E. in St. Louis, April 9, 1949.

"What type of work do you feel you would like to do?" The student's answer may well be one of the most important statements in his engineering career. Yet, on what does he base his decision? In the experience of the writer, slightly over one-half of the students have reached this decision because of a strong liking for some particular course or professor. If the applicant enjoyed his Motion and Time Study Course, he may ask for production work. If he disliked machine design, he may say, "Anywhere but on a board." The teacher of *any* engineering course, whether he realizes it or not, is influencing men in the choice of their careers. Naturally, there are other influences on the student resulting from actual experiences or from consultations with friends and relatives in Engineering work.

During the past few years, many companies have had difficulty in hiring well-qualified men for design. Too many students say, "I don't want to be stuck on a board." If the student is queried further, the interviewer finds that he often was unenthusiastic about his design courses, and feels that design work in industry may be equally distasteful. In many cases the student may not be basically qualified for this type of work. However, we have hired graduates in our one-year training course with expressed interest in other departments. During their short period of training in the Engineering Department in the orientation course, they discover that design is more creative and interesting than they had imagined. Some of these men have altered their original goal and have made engineering design their career. Many more students today could find a lifetime of happiness and service in design, but are steered away from it by incorrect impressions obtained in college courses. This is not necessarily a criticism of machine design courses or professors. It is realized that certain principles must be taught in a limited number of hours. In most cases there is neither time nor staff to allow each student to carry out a separate project. It would also be impossible to duplicate conditions in industry, but an alert and well-informed teacher can help his students understand the relation of what they are doing as students to what a designer may do in industry. Thus a more nearly correct picture of design may be presented to the student. Naturally, this picture will not always be favorable as many men are not well suited to this endeavor.

This same misunderstanding occurs in other fields as well as design. Nearly every young engineering student likes to be around machinery. His laboratory courses give him this opportunity, and he may build up in his mind a strong liking for a field he calls "testing." Perhaps his greatest contribution could be in production, but seldom gets into this branch of industry because he seldom asks for it. Industry may have a poor "tester" or development engineer and have lost a capable production man. Again, an incorrect impression gained in a college course has led to unsatisfactory placement.

After a day's interviewing on a campus, it is readily apparent to the interviewer who the influential professors are. Student after student comes in to the interview with a burning desire for the same type of work. I usually seek out these professors to know them better. Without exception, they are men with a broad understanding of the end point of a student's training—the work he will do in industry.

Thus, some responsibility for the proper placement of the graduate must fall on each professor or instructor who influences the thinking of the undergraduate. True, this influence is unwitting and involuntary, but nevertheless it does exist and plays an important role in determining the future of the graduate.

Department Heads and Placement Directors guide general placement policies. They usually maintain the contacts with representatives of industry during their interviewing visits to the campus. How-

ever, the instructors and professors who may have the greatest basic influence on the student in placement matters could very well be better prepared to give guidance on placement as the student progresses through his four years of engineering.

Vehicles to Better Understanding

The professors or instructors of routine undergraduate courses have usually had some practical or industrial experience in the field they are teaching. The following are several ideas for strengthening this knowledge and understanding of modern industry. As implied earlier, the primary reason for these proposals is to lead to better placement of the graduate. I think you will agree that they will make for more effective teaching as well.

Several companies have provisions for giving summer employment to engineering students. Other companies are considering the inauguration of such programs. Among other things, this training is intended to allow the student to become familiar with industry and opportunities that might await him in different departments. A few companies try to accomplish this goal by giving the student training in several different divisions of the office and factory. Too often the student does one routine job for the entire three months. He understands quite thoroughly the jobs that run over his particular radial drill. However, is he any better qualified to judge his fitness for product reasearch? Or for Sales?

On the other hand, suppose this Company employed, during the summer months, a college instructor or assistant professor. The professor is qualified to handle responsible engineering work. He is more mature and has a broader outlook than a student. If he were given work of a technical nature in the field of his specialty, he could likely make a real contribution to the Company's engineering program even during his short stay. To refer to an earlier illustration, a machine design professor might well work in industry during the summer on some design problem that has been laid aside because it is not pressing. When he returns to his classes in the fall he would likely weave into his teaching the techniques and methods used by industry, making his course more practical and interesting. Students could come to him to receive guidance in this field. Thus, one professor might influence many students. The Company has accomplished its goal more completely than it possibly could by the employment of one student.

This is not intended to discourage the employment of college students by industry during vacation periods. It is intended to illustrate the greater benefit obtained by the employment of instructors if the goal is to help the students in placement matters. This suggestion is not original, but its intended results may be. When our Company was considering the employment of professors during the summer vacation period or for sabbatical leaves, a warning was given us by the Head of Mechanical Engineering at a large midwestern university. Rather than have us select the man from those desiring this type of work, and then place him on any assignment, he suggested we present to the College Department Head the kinds of technical assignments available so that he could choose the man from his staff best suited to fill them. This would insure the greatest satisfaction on the part of both parties.

It has been our custom to spend two or three days on each college campus when we interview engineering seniors. On one particular campus, our representative usually eats lunch with one of the Department Heads. However, each day there is also present at the lunch table one of the instructors or assistant professors from that Department. Often, he is a rather young man, new to the profession. This young professor enters into the discussion at the table whether

on the latest type of industrial development or on the type of salad dressing. But he gets the chance to meet representatives from industry and to swap ideas. He discovers what openings exist and the types of men desired to fill these vacancies. In other words, he gets the opportunity to observe the end point of his work—the placement of the graduate. Now it is clearly impractical to have each instructor at lunch every day. However, there are usually enough visitors from industry so that nearly every week during the spring, the young professor might spend some time with industrial people.

It is about the time of year for annual senior inspection trips. College and industrial men alike are well acquainted with these tours of industrial and business establishments. In most cases there are from thirty to a hundred students who spend a few hours going up and down the aisles of production lines viewing operations first-hand. It is a very worthwhile idea and should be continued and expanded.

Professorial Visitations

But, too often, the students gain merely a general impression. If professors are to influence students on placement matters they should be even better informed. Realizing this, about two years ago we invited to visit us a group of professors of theoretical and applied mechanics from one of the nearby universities from whom we hire many men. We planned a little different type of inspection trip than was ordinarily arranged for students. The professors drove over in cars early to spend the entire day in our Research Department. Our Staff Engineers acted as escorts during the general tour of Research activities in the morning. The size of each group was limited to four. Occasionally, as much as twenty minutes was spent in one spot answering the questions of our guests, and giving more details than were readily apparent from a visual inspection of the machinery. Luncheon was a leisurely affair. Between each Company man was a professor in order to stimulate acquaintance between the two groups. In the afternoon our guests and our engineers divided into small discussion groups of from five to seven men to discuss technical problems in fields of mutual interests. Fancy speeches were out. Just before dinner, members of our staff discussed the progress of men who had recently graduated from the college. Now these professors who visited us were representative of an entire college department from the newest instructor to the Department Head. They gained an entirely different picture of the Company than would a group of students watching parts being machined and assembled. They got to know our men and to understand their problems and goals. Needless to say, this experiment has been repeated with a group from another college. It is a slow process, but a thorough one. What's more, its influence is lasting.

Perhaps this type of program is a little too ambitious to work with all industries. However, it would seem to be part of the job of each professor to be generally informed on the companies where numbers of his graduates are placed. This job is easy to push to the background when days are so fully occupied with duties on the campus; but it would seem important enough to be placed, occasionally, ahead of routine business. Incidentally, the spark in such a contact between industry and the college may have to be generated by the college.

We often have small groups of students visit our plant on their own initiative to become acquainted with the factory. I cannot remember any group of professors who came to us under like circumstances. However, they would certainly be welcomed and given the time of top flight engineering people.

Incidentally, in all of the above sug-

gested means of contacts between college men and industry, the road is a two-lane highway. Each group influences the other. Industrial people may find real help in the solution of technical problems. They may become more aware of the value of an engineering education and make places for more graduates.

It might be well to stop here for a moment to add a word of caution. As you know, a little knowledge can be a dangerous thing. Teachers in college may form an opinion of industry from merely one contact. As an illustration, one professor of mechanical drawing had worked several months in the Engineering Department of a medium sized industry. He had been under poor supervision, which was later changed. However, he was prejudiced by this experience towards all industry and especially Engineering Department work. His attitude was reflected in his students when they discussed employment with industrial interviewers.

Student's Viewpoints

It is our policy to question each student during the interview as to what he means by Sales or Testing or Design. These departments are organized differently in different companies. In one, Sales may consist of direct selling to customers, where in another, Sales may consist of acting as a technical consultant to salesmen. The requirements and responsibilities of the jobs are much different, yet in both cases the brief job description is Sales. Because of this divergence in organization between companies, the wider the professor's contacts with different industries both large and small, the better job of guidance he may do.

This condition is a little like the opinion that an industrial man may get from a single contact with a college. This spring a manager from another Department went with our regular representative to aid in the interviews of students. At the first college visited, there were few men interested in the type of work he supervised. In general, they were not too well informed. He felt that his time could have been spent better by remaining at the factory. However, after three and four visits to different colleges, his attitude changed. He began to appreciate the problems of the colleges, and by the law of averages talked with more seniors interested in his specialty. Now his opinions are the best, but if his contacts had ceased after his first visit, he would likely have been quite intolerant of our engineering education and placement systems.

So don't let one contact with industry or business on the part of a staff member of a college be sufficient to inform him. No two industries are alike and methods are continually changing. An up-to-date clear understanding should replace old prejudices if they exist.

Placement is not something to be thought about only during the last semester of the senior year. The end point of their college work must be kept alive in the minds of students at all times. This will allow more direction to their efforts during their formal scholastic training. Professors of undergraduate courses require an up-to-date understanding of industry if they wish to exert the right influence during these idea forming years.

Other Influences on Students

The influence of the teacher on a student's occupational interests has been brought out. The effect this may have on the student's placement has been discussed. However, there is another field in which each instructor exerts a strong influence which may well have even a greater bearing on the student's placement and his future success and happiness. This is the field of correct dealing with people, and the ability to get along well with others. Because, as you know, the instructor is not merely a purveyor of technical information. He cannot

help but teach by example whether good relations or bad. Take, for example, the professor who is habitually careless or even sloppy in his appearance. To the student he is still a successful engineer. So the student may come to the interview with no tie and a day's growth of beard. This has happened. The results are obvious. Or take the case of a professor of mechanical engineering who was intolerant towards economics courses. His attitude was reflected in his students by their feeling of a disdain for any subject not strictly technical. This, incidentally, reduced their grade point average in economics, but more seriously encouraged them to neglect to round out their educations. The professor who uses profanity encourages his students to do likewise. And some students feel the interviewer won't think them a regular guy unless they say "hell" and "damn" or something else even more "manly." A professor who bawls out a slow student before the entire class does harm not only to that student, but at the same time gives an object lesson in poor human relations to the rest of the group. The veterans now in school are older and are perhaps influenced less by these actions than are the younger students. However, the younger students will soon predominate.

Conclusion

Who is responsible for placement? Many people—yes—but perhaps most of all the men under whom our students study. During these days of enlarged staffs which were rapidly expanded upon conclusion of the war, more attention might be given to the understanding of the end point of formal education by these teachers. This paper has proposed three definite means, all of which have been operated successfully under certain conditions. These are not simple solutions. Problems involving people seldom have simple answers. However, it is hoped these proposals will also bring about a closer bond of friendship and understanding between individuals in education and in industry and business which cannot help but strengthen both.

So no matter what happens to be the placement arrangement at an engineering college, it is the professors who have the greatest influence on the student. Through their teaching of technical subjects, the students gain an insight into engineering work as a career. These teachers have done an unusually fine job in the past. With a closer bond between them and industry they will be in a position to be even more effective. This will promote a happier and more successful career for the graduate.

Minutes of Executive Board Meeting

A meeting of the Executive Board of The American Society for Engineering Education was held on Friday, September 1, 1950, at Northwestern University, Evanston, Illinois. Those present were: F. M. Dawson, *President,* H. H. Armsby, L. E. Grinter, G. A. Rosselot, C. L. Skelley, F. E. Terman, A. B. Bronwell, and M. Wiltberger.

Report of the Secretary

The Secretary reported that substantially all of the Committees have been appointed. F. L. Wilkinson, Jr. was approved as Chairman of the Costs of Engineering Education Committee. Thorndike Saville was appointed as representative to ECPD for a three year term.

Report of the Treasurer

The report of the Treasurer was presented and accepted. At the suggestion of the Secretary, the Board approved an increase in the Secretary's bond from $5,000 to $35,000.

A request of ECPD for an increased appropriation of $500 for the coming year was deferred, pending further information and clarification of the probable future financial position of the ASEE.

Report of the Vice Presidents

Mr. Armsby stated that the University of Tennessee had submitted a constitution for a Branch of the ASEE. A motion to approve authorization of the Branch was passed. The approval of a constitution of the University of Maine was referred to the Committee on Sections and Branches.

Mr. Armsby reported that the names of several ASEE members have been submitted to the State Department and referred to the White House as nominees for the Advisory Board which is to assist the State Department in the basic policies relating to the Point Four Program. He stated that, in addition to the Advisory Board, a number of Committees representing specialized areas will be appointed. It may be possible to have Society members appointed either to the Advisory Board or to one or more of the working Committees.

Dr. Grinter presented the requests for ASEE sponsorship of Summer Schools which were submitted by the Engineering Drawing Division, Humanistic-Social Division, and the Mechanical Engineering Division. The Board voted to approve ASEE sponsorship of these three Summer Schools.

Dr. Grinter discussed the progress of the Committee on Improvement of Teaching. He stated that the work of the Committee will be subdivided into three categories, with subcommittees arranged geographically so as to minimize travel. He also stated that the Committee will attempt to get each dean of engineering to establish a local subcommittee within his own institution. Activities of the institutional subcommittees will be reported back to the central Committee in order to provide a pool of case studies.

Dean Terman, reporting for the ECAC, presented the views of the Executive Committee of the ECAC on the proposal of the Committee on International Relations to set up ASEE sponsored fellowships in engineering colleges. According to the proposed plan, participating institutions would each designate one or more scholarships or fellowships to be granted to foreign students and would assist the student in obtaining living expenses. Dean Terman stated that the Executive Committee of the ECAC accepted the plan, although there appeared to be mild skepticism on the part of the Committee

members as to whether or not the plan would be widely adopted.

Dr. Rosselot reported that the ECRC is planning to publish a Directory of Research. This project may be in cooperation with the Research and Development Board of the U. S. Military Establishment.

Constitutional Amendment Providing for Affiliate Branches in Technical Institutes

Vice President Armsby submitted a proposed amendment to the Constitution which would provide for authorization of Affiliate Branches in Technical Institutes. It would also provide for clarification of other matters relating to the authorization of Sections and Branches. The amendments were referred to the Committee on Constitution and By-Laws.

Emergency Educational Programs

The Secretary reported on a conference which he had with Dean Saville regarding the planning of emergency educational programs. Experience during the last war has indicated the necessity of adequate liaison between the Society and representatives in the Military Establishment as well as other interested government agencies responsible for planning educational programs. Dean Saville suggested that a meeting of his Coordinating Committee, together with representatives of the Military Establishment and other interested governmental agencies, be held in Washington, D. C. at the time of the ECRC and ECAC meetings. This meeting would consist of a frank and open discussion of the whole problem of emergency educational programs. Appropriate follow up action could then be taken by various committees of the Society.

Plans For Meetings In Washington, D. C. November 16–17, 1950

The ECAC and ECRC plan to have joint meetings in Washington, D. C. immediately after the Land Grant Association meetings.

These meetings will center around the following topics: 1) general problem of proper utilization of technical manpower; 2) manpower controls; 3) problem of training; 4) utilization of research facilities in universities. The meetings will be open to members of the Society unless a closed meeting appears desirable.

There will be a breakfast meeting of the General Council at 7:45 until 9:45 A.M. on Thursday, November 16.

Cooperation With American Council On Education

A plan has been worked out with the ACE whereby bulletins of the ACE will be sent to the Society for distribution to deans of engineering colleges. The Society will pay the cost of these bulletins.

The Executive Board voted to suggest to ACE that an engineering college president or dean be added to their Committee on Relationships of Higher Education to the Federal Government.

National Science Foundation

President Dawson stated that he had received word that the Appropriations Committee of the House of Representatives has removed the $500,000 appropriation for organization of the National Science Foundation from the Appropriations Bill. He reported that he had sent a telegram to Senator O'Mahoney urging that funds be appropriated for the Science Foundation and stating that this is more important than expenditure of the same amount of money in other phases of the preparedness program.

Vocational Training In U. S. Department of Labor

President Dawson stated that there was a possibility that the National Securities Resources Board would recommend placing the responsibility for vocational training programs in the U. S. Department of Labor. Since the Department of Labor has had very little previous experience with training programs of this nature and the U. S. Office of Education has had very extensive experience, it was felt that

such a move would be extremely unfortunate. Accordingly he sent a telegram to the National Securities Resources Board strongly urging that training programs dealing with the emergency be vested in the U. S. Office of Education rather than in the Department of Labor or other governmental agencies.

Draft Deferment

The Secretary reported that an Advisory Committee under the Chairmanship of Dr. Trytten has submitted to General Hershey a revision in the plan for draft deferment of students. It is expected that action will be taken on this proposal in the near future. Also, President Truman has requested that a provision be inserted in the Universal Military Training bill whereby students who have been accepted by a college or university will be required to take only six months of military training.

E.S.M.W.T. Proposals

Vice President Armsby reported on tentative legislation which is being drawn up by the Office of Education for reactivation of educational programs similar to the E.S.M.W.T. programs.

ECAC Survey of Employment of 1950 Graduates

The Manpower Committee of the EC AC had previously proposed to conduct a survey to analyze the types of jobs accepted by engineering students who graduated in 1950. Because of the military preparedness program, it appeared that this survey would have very little predictive value for future years. The Manpower Committee has proposed studying this matter further with a view toward making a somewhat similar survey to assist in any future mobilization of technical manpower.

Teaching Aids Committee

A suggestion has been made that the Teaching Aids Committee be appointed as a full Committee of the Society rather than as a subcommittee of the Division of Educational Methods. This Committee will solicit funds from industry in order to carry out its evaluation program. In view of the financial responsibility of this group and also in order to focus the attention of the entire Society upon the activities of this Committee, it was proposed that this Committee be made a Committee of the Society and report directly to either the Council or the Executive Board. This was referred to Vice President Grinter for study.

Engineering Centennial of 1952

A motion was made and passed that the ASEE will accept the invitation of the American Society of Civil Engineers to take part in its Centennial in Chicago in 1952.

Respectfully submitted,
ARTHUR B. BRONWELL,
Secretary

Committees, 1950-51

EXECUTIVE BOARD: F. M. Dawson, *Chairman,* State University of Iowa, Iowa City, Ia., H. H. Armsby, L. E. Grinter, G. A. Rosselot, C. L. Skelley, F. E. Terman, A. B. Bronwell.

PROGRAM: Members of the Executive Board.

PUBLICATION: A. B. Bronwell, *Chairman,* Northwestern University, Evanston, Ill., F. M. Dawson, T. Saville, C. L. Skelley, J. S. Thompson.

CONSTITUTION AND BY-LAWS: W. C. White, *Chairman,* Northeastern University, Boston, Mass., H. O. Croft, L. A. Bingham, P. Cloke, K. L. Holderman, J. B. McGivern, M. C. Giannini.

ATOMIC ENERGY CONFERENCES: (Steering Committee): H. H. Armsby, *Chairman,* U. S. Office of Education, Washington, D. C., H. E. Wessman, M. P. O'Brien, O. W. Eshbach, R. C. Ernst, H. B. Hanstein, P. N. Powers, *Subcommittees:* G. W. Gleeson, A. S. Janssen, E. W. Schilling, R. D. Sloan, H. E. Wessman, *Chairman;* E. B. Norris, E. E. Litkenhous, W. J. Seeley, N. W. Dougherty, N. G. Pollard, H. M. Roth, R. C. Ernst, *Chairman;*

COSTS OF ENGINEERING EDUCATION: F. L. Wilkinson, *Chairman,* Rose Polytechnic Institute, Terre Haute, Indiana, H. P. Hammond, W. L. Everitt, M. P. O'Brien, H. S. Rogers, W. R. Woolrich, T. Saville, A. B. Bronwell.

ENGINEERING ECONOMY: W. D. McIlvaine, *Chairman,* University of Alabama, University, Ala.

ENGINEERING SCHOOL LIBRARIES: E. A. Chapman, *Chairman,* Rensselaer Polytechnic Institute, Troy, N. Y., J. E. Allerding, P. Leslie, J. B. O'Farrell, W. R. Harvey, D. A. Webb.

GEORGE WESTINGHOUSE AWARD: R. E. Vivian, *Chairman,* University of Southern California, Los Angeles, Calif.; for four years, H. P. Hammond, F. B. Seely; for three years, N. A. Christensen, R. E. Vivian; for two years, V. L. Doughtie, W. L. Everitt; for one year, E. B. Norris, H. E. Wessman; H. N. Muller, *Ex-Officio.*

IMPROVEMENT OF TEACHING: (Steering Committee): L. E. Grinter, *Chairman,* Illinois Institute of Technology, Chicago, Ill., H. H. Armsby, A. B. Bronwell, J. F. Calvert, J. W. Cell, N. A. Christensen, A. P. Colburn, R. E. Doherty, E. E. Dreese, C. G. Duncombe, R. Eliassen, W. L. Everitt, R. E. Fadum, V. M. Faires, H. P. Hammond, E. Hutchisson, F. C. Lindvall, L. C. Maugh, K. B. McEachron, Jr., B. V. Moore, S. P. Olmsted, J. T. Rettaliata, H. S. Rogers, T. Saville, J. F. D. Smith, H. L. Solberg, B. R. Teare, E. A. Walker, E. Weber, J. G. Woodburn, F. H. Pumphrey.

INDUSTRIAL HYGIENE, SAFETY AND FIRE PREVENTION: D. E. Henderson, *Chairman,* North Carolina State College, Raleigh, N. C., J. J. Ahern, W. N. Cox, G. H. Dunstan, P. N. Lehoczky, J. H. Mathewson, W. F. O'Connor, N. A. Parker, J. F. Piccard, J. C. Stennett, J. K. Walkup.

JAMES H. MCGRAW AWARD: H. P. Rodes, *Chairman,* University of California, Los Angeles, Calif.; for two years, K. L. Holderman, L. V. Johnson, C. S. Jones; for one year, J. T. Faig, C. J. Freund, H. P. Rodes; *Ex-Officio,* E. E. Booher, F. M. Dawson, H. P. Adams.

JUNIOR COLLEGES: H. P. Rodes, *Chairman,* University of California, Los Angeles, Calif., D. E. Deyo, *Vice Chairman,* L. L. Bethel, N. L. Gates, J. Gerardi, R. W. Marsh, L. L., Medsker, R. G. Moses.

LAMME AWARD: N. W. Dougherty, *Chairman,* University of Tennessee, Knoxville, Tenn.; for four years, M. M. Boring, M. P. O'Brien, B. R. Teare; for three years, N. W. Dougherty, R. E. Doherty, W. K. Lewis; for two years, H. P. Hammond, A. A. Potter, W. C. White; for one year, E. D. Ayres, F. Kerekes, G. A. Stetson.

MEMBERSHIP: F. M. Dawson, *Chairman,* State University of Iowa, Iowa City, Ia. *State Chairmen:* J. E. Hannum, Alabama; E. S. Borquist, Arizona; G. F. Branigan, Arkansas; R. E. Vivian, California; T. H. Evans, Colorado; H. J. Lockwood, Connecticut; A. P. Colburn, Delaware; C. H.

Walter, District of Columbia; R. A. Morgen, Florida; F. W. Ajax, Georgia; H. W. Silha, Idaho; J. T. Retalliata, Illinois; F. C. Hockema, Indiana; F. Kerekes, Iowa; W. H. Honstead, Kansas; D. V. Terrell, Kentucky; R. T. Sessums, Louisiana; W. S. Evans, Maine; C. O. Terwilliger, Maryland; G. A. Marston, Massachusetts; C. L. Brattin, Michigan; N. A. Hall, Minnesota; H. V. Flinsch, Mississippi; H. Rubey, Missouri; E. R. Dodge, Montana; W. L. DeBaufre, Nebraska; H. B. Blodgett, Nevada; J. J. Ermenc, New Hampshire; K. H. Condit, New Jersey; M. A. Thomas, New Mexico; J. R. Dunning, P. E. Hemke, New York; R. E. Fadum, North Carolina; L. C. Harrington, North Dakota; R. D. Landon, Ohio; R. L. Langenheim, Oklahoma; R. A. Wanless, Oregon; K. L. Holderman, Pennsylvania; E. M. Pease, Rhode Island; A. Berne-Allen, South Carolina; E. D. Dake, South Dakota; R. M. Boarts, Tennessee; L. B. Ryon, Texas; J. Coulam, Utah; J. A. Bullard, Vermont; R. M. Hubbard, Virginia; H. E. Wessman, Washington; W. A. Koehler, West Virginia; R. A. Ragatz, Wisconsin; H. T. Person, Wyoming; K. F. Tupper, Canada; P. L. Carroll, Mexico; A. R. Hellwarth, Industrial.

COORDINATING COMMITTEE ON RELATIONS WITH THE FEDERAL GOVERNMENT: T. Saville, *Chairman*, New York University, New York, N. Y., T. H. Evans, G. W. Gleeson, D. B. Prentice, A. F. Spilhaus, G. Lobinger, W. R. Woolrich, F. M. Dawson, *Ex-Officio*.

SECTIONS AND BRANCHES: H. H. Armsby, *Chairman*, U. S. Office of Education, Washington, D. C., M. T. Ayers, M. P. Capp, W. H. Carson, David S. Clark, W. L. DeBaufre, M. E. Farris, R. S. Glasgow, W. A. Koehler, R. D. Landon, E. R. McKee, L. G. Miller, G. K. Palsgrove, L. O. Stewart, H. H. Wheaton, R. Z. Williams.

YOUNG ENGINEERING TEACHERS: (Interim Committee), D. L. Trautman, *Chairman*, University of California, Los Angeles, Calif., D. Bergh, S. A. Duran, L. W. Gleekman, V. B. Hammer, T. J. McClellan, F. L. Schwartz, G. C. Szego, G. C. Wilson.

REPRESENTATIVES OF THE SOCIETY ON VARIOUS COMMITTEES, BOARDS, AND COMMISSIONS:

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: Council representatives: W. R. Woolrich (1951), J. R. Van Pelt (1951).

AMERICAN COUNCIL ON EDUCATION: A. B. Bronwell (1953), H. T. Heald (1952), S. S. Steinberg (1951).

AMERICAN STANDARDS ASSOCIATION:

Z10—Symbols and Abbreviations: W. A. Lewis, *Chairman*, T. C. Hanson, P. J. Kiefer, W. B. Plank, M. C. Stuart, C. C. Whipple.

Z14—Drawings and Drafting Room Practice: H. C. Spencer, *Chairman*, F. G. Higbee, R. P. Hoelscher, W. J. Luzadder, R. S. Paffenbarger, C. L. Svensen, C. J. Vierck.

Z15—Graphic Presentation: R. S. Paffenbarger, *Chairman*, D. P. Adams, A. S. Levens, R. O. Loving.

Z32—Graphical Symbols and Drawings: I. L. Hill, *Chairman*, J. G. McGuire, R. T. Northrup.

A62—Coordination of Dimensions of Building Materials and Equipment: R. A. Caughey.

C61—Electric and Magnetic Magnitudes and Units: Harold Pender, C. V. O. Terwilliger, C. F. Rehberg.

CHARLES A. COFFIN FELLOWSHIPS AND RESEARCH COMMITTEE: F. M. Dawson.

EDUCATIONAL TESTING SERVICE, ADVISORY COUNCIL: H. R. Beatty, O. W. Eshbach, F. M. Dawson, *Ex-Officio*.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT: W. R. Woolrich (Oct. 1952), H. T. Heald (Oct. 1951).

ENGINEERS JOINT COUNCIL:

COMMITTEE ON UNITY IN THE ENGINEERING PROFESSION: T. Saville.

GENERAL SURVEY COMMITTEE: M. M. Boring.

COMMITTEE ON SURVEY OF TECHNICAL MANPOWER NEEDS: F. M. Dawson, H. H. Armsby, Thorndike Saville.

ENROLLMENT STATISTICS (Joint Committee with U. S. Office of Education): H. P. Hammond, *Chairman*, A. B. Bronwell, G. D. Lobingier.

NATIONAL BUREAU OF ENGINEERING REGISTRATION (Advisory Board): N. W. Dougherty.

NATIONAL RESEARCH COUNCIL: F. M. Dawson, G. A. Rosselot.

Divisions, 1950-51

AERONAUTICAL: W. C. Nelson, *Chairman*, University of Michigan; A. E. Cronk, *Vice Chairman;* C. N. Sanford, *Secretary;* H. W. Barlow, *Member of Council*, 1951.

AGRICULTURAL: H. J. Barre, *Chairman*, Purdue University; A. W. Farrall, *Vice Chairman;* O. C. French, *Secretary.*

ARCHITECTURAL: L. R. Blakeslee, *Chairman*, University of Detroit; W. W. Dornberger, *Vice Chairman;* P. E. Soneson, *Secretary;* S. A. Smith, *Member of Council*, 1952.

CHEMICAL: J. S. Walton, *Chairman*, Oregon State College; N. H. Ceaglske and G. C. Williams, *Vice Chairmen;* R. L. Savage, *Secretary;* R. A. Ragatz, *Member of Council*, 1951.

CIVIL ENGINEERING: Harry Rubey, *Chairman*, University of Missouri; E. H. Gaylord, *Vice Chairman;* F. W. Stubbs, *Secretary;* H. W. Wood, *Editor, CE Bulletin; Directors:* W. L. Moore, F. W. Stubbs, A. A. Jakkula, W. Raeder; W. M. Lansford, *Member of Council*, 1952.

COOPERATIVE ENGINEERING EDUCATION: D. C. Hunt, *Chairman*, University of Detroit; H. R. Bintzer, *Vice Chairman;* A. O. Taylor, *Secretary;* M. B. Robinson, *Member of Council*, 1951.

EDUCATIONAL METHODS: F. H. Pumphrey, *Chairman*, University of Florida; H. R. Beatty, *Vice Chairman;* G. S. Speer, *Secretary;* E. A. Walker, *Member of Council*, 1952.

ELECTRICAL: T. H. Morgan, *Chairman*, Worcester Polytechnic Institute; F. O. McMillan, *Vice Chairman;* H. E. Hartig, *Secretary;* G. B. Hoadley, *Member of Council*, 1951.

ENGINEERING DRAWING: R. S. Paffenbarger, *Chairman*, Ohio State University; C. H. Springer, *Secretary; Executive Committee:* J. G. McGuire, W. E. Street, C. E. Rowe, H. E. Grant, R. S. Paffenbarger; T. T. Aakhus, *Editor;* J. Gerardi, *Editor, T-Square Page;* C. J. Vierck, *Advertising Manager;* W. J. Luzadder, *Circulation Manager;* H. C. Spencer, *Member of Council*, 1952.

ENGLISH: J. H. Pitman, *Chairman*, Newark College of Engineering; G. J. Christensen, *Vice Chairman*, and *Secretary;* R. L. Shurter, *Member of Council*, 1951.

EVENING ENGINEERING EDUCATION: S. E. Winston, *Chairman*, Illinois Institute of Technology; L. W. Krogh, *Vice Chairman;* H. Torgersen, *Secretary*, H. R. Beatty, *Member of Council*, 1951.

GRADUATE STUDIES: J. H. Rushton, *Chairman*, Illinois Institute of Technology; A. Colburn, *Vice Chairman;* C. O. Harris, *Secretary; Directors:* H. L. Solberg, G. B. Hoadley, N. J. Hoff, D. F. Peterson, H. E. Wessman; J. H. Rushton, *Member of Council*, 1952.

HUMANISTIC-SOCIAL STUDIES: S. W. Chapman, *Chairman*, University of Washington; C. W. Condit, *Secretary; Executive Board:* H. R. Bartlett, P. E. Mohn, J. W. Shirley, Hallett Smith, B. R. Teare, F. L. Wilkinson; J. E. Thornton, *Member of Council*, 1951.

INDUSTRIAL ENGINEERING: H. R. Beatty, *Chairman*, Pratt Institute; J. A. Apple, *Vice Chairman;* W. G. Ireson, *Secretary;* E. Laitala, *Member of Council*, 1952.

MATHEMATICS: W. C. Krathwohl, *Chairman*, Illinois Institute of Technology; J. H. Zant, *Secretary; Directors:* F. H. Miller, C. R. Wylie, Jr., D. F. Gunder; H. K. Justice, *Member of Council*, 1951.

MECHANICAL ENGINEERING: L. C. Price, *Chairman*, Michigan State College; H. Kuenzel, *Vice Chairman;* E. L. Midgette, *Secretary;* H. A. Bolz, *Member of Council*, 1952.

MECHANICS: R. G. Sturm, *Chairman*, Purdue University; *Executive Board:* S. Ward, G. W. Smith, W. M. Lansford, R. G. Sturm, G. Murphy, A. L. Miller, J. Marin, G. H. MacCullough; E. C. Clark, *Member of Council*, 1951.

MINERAL ENGINEERING: H. H. Power, *Chairman*, University of Texas; A. Butts, *Vice Chairman;* W. J. Rundle, *Secretary;* T. L. Joseph, *Member of Council*, 1952.

PHYSICS: E. Hutchisson, *Chairman*, Case Institute of Technology; F. G. Slack, *Vice Chairman;* G. P. Brewington, *Secretary; Executive Board:* J. G. Potter, H. L. Dodge, M. W. White; C. E. Bennett, *Member of Council*, 1951.

RELATIONS WITH INDUSTRY: B. R. Teare, *Chairman*, Carnegie Institute of Technology; M. J. Bergen, *Vice Chairman;* E. N. Baldwin, *Secretary-Treasurer; Executive Committee Directors:* For three years: E. M. Baldwin, J. F. Downie

Smith, D. S. Bridgeman; for two years: E. C. Koerper, M. J. Bergen, B. R. Teare, Jr.; for one year: J. C. McKeon, Jr., C. J. Freund, K. B. McEachron, Jr.; J. C. McKeon, Jr., *Member of Council*, 1951.

TECHNICAL INSTITUTE: H. P. Adams, *Chairman*, Oklahoma A. & M. College; K. O. Werwath, *Vice Chairman;* H. P. Rodes, *Secretary;* K. L. Holderman, *Member of Council*, 1951.

Sections, 1950-51

ALLEGHENY: D. F. Miner, *Chairman*, Carnegie Institute of Technology; E. B. Stavely, *Vice Chairman;* J. W. Graham, Jr., *Secretary;* W. A. Koehler, *Member of Council*, 1951.

ILLINOIS-INDIANA: W. C. Knopf, *Chairman*, Northwestern University; D. G. Ryan, *Vice Chairman;* C. E. Watson, *Secretary; Executive Committee:* D. S. Clark, R. M. Ross, H. P. Hall, R. N. Shreve, C. C. Stevason, E. Danner, B. A. Fisher; D. S. Clark, *Member of Council*, 1952.

KANSAS-NEBRASKA: F. W. Norris, *Chairman*, University of Nebraska; Wilson Tripp, *Vice Chairman;* A. S. Andes, *Secretary-Treasurer;* W. L. DeBaufre, *Member of Council*, 1951.

MICHIGAN: H. M. Dent, *Chairman*, General Motors Institute; W. P. Godfrey, *Vice Chairman;* F. L. Schwartz, *Secretary-Treasurer;* L. G. Miller, *Member of Council*, 1952.

MIDDLE ATLANTIC: C. H. Willis, *Chairman*, Princeton University; G. B. Thom, *Vice Chairman;* William Allan, *Secretary-Treasurer;* M. T. Ayers, *Member of Council*, 1951.

MISSOURI: R. J. W. Koopman, *Chairman*, Washington University; I. H. Lovett, *Vice Chairman;* J. R. Lorah, *Secretary;* R. Z. Williams, *Member of Council*, 1951.

NATIONAL CAPITAL AREA: R. B. Allen, *Chairman*, University of Maryland; W. Oncken, *Vice Chairman;* L. K. Downing, *Secretary-Treasurer;* R. S. Glasgow, *Member of Council*, 1952.

NEW ENGLAND: W. C. White, *Chairman*, Northeastern University; W. E. Keith, *Secretary;* E. R. McKee, *Member of Council*, 1951. (New officers to be elected in October, 1950).

NORTH MIDWEST: E. W. Johnson, *Chairman*, University of Minnesota; K. F. Wendt, *Vice Chairman;* A. O. Lee, *Secretary; Executive Board:* L. A. Ware, S. J. Chamberlain, R. J. Panlener, George Swenson, A. W. Anderson; L. O. Stewart, *Member of Council*, 1952.

OHIO: W. F. Brown, *Chairman*, University of Toledo; S. M. Marco and P. L. Rea, *Vice Chairman;* L. D. Jones, *Secretary;* R. D. Landon, *Member of Council*, 1951.

PACIFIC NORTHWEST: A. S. Janssen, *Chairman*, University of Idaho; C. O. Reiser, *Vice Chairman;* Paul Mann, *Secretary;* O. E. Osburn, *Member of Council*, 1950.

PACIFIC SOUTHWEST: E. D. Howe, *Chairman*, University of California, Berkeley; S. F. Duncan, *Vice Chairman;* R. G. Moses, *Secretary-Treasurer; Executive Committee:* H. B. Blodgett, C. T. Reid, R. J. Smith; H. H. Wheaton, *Member of Council*, 1951.

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Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Carnegie Institute	April, 1951	D. F. Miner Carnegie Institute
Illinois-Indiana	Purdue University	May 20, 1950	D. S. Clark, Purdue University
Kansas-Nebraska	Kansas State College	Oct. 13–14, 1950	F. W. Norris, University of Nebraska
Michigan	General Motors Institute	May 20, 1951	H. M. Dent, General Motors Institute
Middle Atlantic	Stevens Institute of Technology	Dec. 9, 1950	C. H. Willis, Princeton University
Missouri	Missouri School of Mines	April 1, 1950	C. M. Wallis, University of Missouri
National Capital Area	Naval Ordnance Laboratory	Oct. 3, 1950 Feb. 6, 1951 May 12, 1951	R. B. Allen, University of Maryland
New England	University of New Hampshire	Oct. 14, 1950	W. C. White, Northeastern University
North Midwest	University of Minnesota	Oct. 6 & 7, 1950	C. J. Posey, University of Iowa
Ohio	Ohio State University	April 29, 1950	S. R. Beitler, Ohio State University
Pacific Northwest	University of Idaho	1951	A. S. Janssen, University of Idaho
Pacific Southwest	Stanford University	Dec. 28 & 29, 1949	R. J. Smith, San Jose State College
Southeastern	Buena Vista Hotel	March 22, 23, 24, 1951	E. B. Norris, Virginia Polytechnic Institute
Southwestern	Texas A. & M. College	April, 1950	W. H. Carson, Oklahoma University
Upper New York	University of Buffalo	Oct. 13 & 14, 1950	F. H. Thomas, University of Buffalo

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